

Chambers's
DICTIONARY *of* SCIENTISTS



ALBERT EINSTEIN celebrates his seventyeth birthday at home in Princeton
March 14th, 1949.

Chambers's
DICTIONARY
OF SCIENTISTS

A. V. HOWARD, B.Sc.

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CONTENTS

PREFACE	-	-	-	-	-	-	VI
DICTIONARY	-	-	-	-	-	COL. I	
INDEX	-	-	-	-	-	COL. 479	
NOBIL LAUREATES	-	-	-	-	-	BACK END-PAPERS	

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ILLUSTRATIONS

	COL.		COL.
John Couch Adams - - -	6	W. K. Heisenberg - - -	105
Carl D. Anderson - - -	105	Sir William Herschel - - -	218
Sir E. V. Appleton - - -	17	V. F. Hess - - -	105
Svante Arrhenius - - -	23	Sir F. Gowland Hopkins - - -	227
Francis W. Aston - - -	26	Thomas Henry Huxley - - -	231 ²
Francis Bacon - - -	30	Edward Jenner - - -	241
Roger Bacon - - -	32	Joseph Kaplan - - -	247
John Logie Baird - - -	35	William Thomson, Lord Kelvin - - -	252
Friedrich Bergius - - -	50	Johannes Kepler - - -	254
Joseph Black - - -	58	Irving Langmuir - - -	271
Niels Bohr - - -	62	Antoine Lavoisier - - -	275
Hon. Robert Boyle - - -	67	Ernest O. Lawrence - - -	277
Sir W. H. Bragg - - -	70	Carolus Linnaeus - - -	286
Tycho Brahe - - -	71	Joseph Lister - - -	287
Sir David Brewster - - -	74	James Clerk Maxwell - - -	306
Sir J. D. Cockcroft - - -	103	Dmitri Mendelejeff - - -	311
Arthur H. Compton - - -	105	Albert Michelson - - -	315
Nicolaus Copernicus - - -	109	Robert A. Millikan - - -	318
Sir William Crookes - - -	114	Sir Isaac Newton - - -	331
Mme. Marja Curie - - -	115	Philippus Paracelsus - - -	347
Charles Darwin - - -	122	Louis Pasteur - - -	350
Sir Humphry Davy - - -	123	Ivan Petrovitch Pavlov - - -	351
René Descartes - - -	130	Max Planck - - -	362
Sir James Dewar - - -	131	Joseph Priestley - - -	366
Sir Arthur Eddington - - -	143	John Ray - - -	375
Thomas Alva Edison - - -	145	Benjamin Thompson, Count	
Albert Einstein - - -	<i>frontispiece</i>	Rumford - - -	391
Michael Faraday - - -	155	Ernest, Lord Rutherford - - -	394
John Flamsteed - - -	162	Glenn T. Seaborg - - -	403
Sir Alexander Fleming - - -	163	Harlow Shapley - - -	407
Benjamin Franklin - - -	169	Sir J. J. Thomson - - -	435
Sigmund Freud - - -	174	Harold C. Urey - - -	446
Galileo Galilei - - -	178	Sir R. A. Watson-Watt - - -	458
Karl F. Gauss - - -	182	Sir Frank Whittle - - -	466
Rev. Stephen Hales - - -	203	William Hyde Wollaston - - -	471
William Harvey - - -	210		

The illustrations in columns 6, 30, 58, 67, 70, 114, 122, 123, 131, 155, 162, 169, 203, 210, 218, 231, 241, 287, 306, 366, 375, 391, 394, 435, and 471 are reproduced by courtesy of the National Portrait Gallery, London.

PREFACE

THIS compilation of biographical details is intended as a handy book of reference, and is in no sense expected to satisfy completely the student's curiosity concerning the lives of scientists. The various well-known histories of particular sciences and such books as the *Dictionary of National Biography* will furnish fuller details, but many students have neither the time nor the opportunity to consult a wide range of reference books. For these I have endeavoured to collect the essential facts about the names frequently encountered in the literature of science, so that they may be seen in perspective with regard to time, place and achievement.

It is becoming increasingly obvious that the history of science is of fundamental importance to all students, and any approach which tends to break down the unnatural separation of learning into two discrete sections, science and arts, should be encouraged to the full. A comparatively small proportion of those who study science in our schools ever become scientists in the strict sense of the word, but all should be brought to realise the potentialities of modern research. It is as ridiculous for the layman to blame the scientist for the destruction caused by the atomic bomb as it is for the scientist to disclaim all responsibility for the use to which it has been put. Both should be prepared to face the future with open eyes, for apart from the terrifying lethal prospects of further improvement in scientific warfare there are dangerous rocks ahead in the field of experimental biology. The nineteenth century was a battlefield of controversy over the doctrine of evolution; are we any better prepared to face the human problems raised by artificial insemination, selective reproduction and the possible determination and control of sex?

It is my hope, then, that in a small way this book will help to focus attention on the path and rate of progress in scientific knowledge, and that the proportion of 20th and late 19th century scientists included will emphasise the rapidity of recent developments. Only the difficulty of assessing the value of contemporary work prevents that number from being much greater.

This dictionary is, of course, a record of the landmarks of discovery in science, and it is necessary here to point out that there has been, and still is, a considerable amount of controversy with respect to priority of discovery in many instances. This was particularly true in the field of synthetic chemistry and also in mechanical invention, while the two classical cases of the introduction of the differential calculus and the discovery of Neptune will be familiar to everyone. The balance of opinion has been quoted here without any attempt to enter into argument for or against.

The arrangement of articles is alphabetical, except in the case of successive generations of the same family, when chronological order is adopted. Hyphenated nationalities in the descriptions indicate not parentage but countries of birth and adoption. Alternative names or forms of names are generally given in brackets. It will be noticed that, in order to facilitate reference from the Index, the columns and not the pages are numbered. The subject Index has been introduced to enable the reader to trace parallel workers in any particular field of science, and of course its value in the case of individual invention will be readily appreciated.

In conclusion I should like to record my thanks to Mr. W. Taylor McLeod of Messrs. W. & R. Chambers, Ltd., for help in the final preparation of the manuscript, and in particular for his careful scrutiny of details which has greatly reduced the author's errors and omissions. That some errors yet lurk undiscovered seems certain; the Publishers will receive with gratitude any notification of these for future correction.

SUPPLEMENT

Adrian, Edgar Douglas (col. 7)
President of British Association 1954;
created Baron 1955.

Alder, see Diels (below).

Bloch, Felix
Swiss-German-American physicist
b. 1905, Zurich

After early education at Zurich, Bloch studied and worked with Heisenberg, Bohr, and Fermi. In 1934 he left Europe for America, where he became professor of theoretical physics at Stanford University. Among much experimental research in nuclear physics, Bloch developed the nuclear induction method for precise measurement of nuclear magnetic moments, and obtained (with Purcell) the Nobel award for physics in 1952.

Born, Max
German physicist
b. 1882, Breslau

Son of a Breslau professor, Born was educated there and at several other universities. He was professor of theoretical physics at Göttingen from 1921 to 1933, when he left for England, becoming a lecturer at Cambridge, then (from 1936) professor of natural philosophy at Edinburgh. His principal work has been in the field of quantum physics, where his statistical interpretation of wave functions brought him the 1954 Nobel award for physics (shared with Bothe). Other important work has concerned the theory of crystal lattices.

Bothe, Walther
German physicist
b. 1891, Oranienburg

Since 1934 head of the Max Planck Institute for Medical Research at Heidelberg, and professor of the university there, Bothe is associated with the development of 'coincidence' technique in counting processes (which brought him the Nobel Physics award for 1954, shared with Born) and with pioneer work in cosmic rays and nuclear reactions.

Cherwell, Frederick Alexander
Lindemann, Baron.
Created Viscount 1956
(see col. 96)

Diels, Otto
German organic chemist
b. 1876, Hamburg

Professor of chemistry at Kiel University 1916-48 (thereafter emeritus professor), Diels, with his pupil Kurt Alder (b. 1902; professor in Cologne since 1940) demonstrated in 1928 the 'Diels-Alder synthesis' (Diels-Alder reaction), which is of far-reaching importance and application, especially to the development of the plastics industry. Diels and Alder were jointly awarded the Nobel prize for chemistry in 1950.

du Vigneaud, Vincent
American biochemist
b. 1901, Chicago

After graduating at the University of Illinois, du Vigneaud worked in the du Pont Jackson laboratories and in Philadelphia General Hospital. In 1938 he became professor of biochemistry at Cornell University, where his department achieved fame for such feats as the synthesis of penicillin and oxytocin and the discovery of the structure of biotin (vitamin H). He received the 1955 Nobel award for chemistry for his work on the synthesis of pituitary hormones, including the anti-arthritis substance ACTH.

Einstein, Albert
d. at Princetown, N.J., April, 1955
(see cols. 146-7)

Enders, John Franklin
American bacteriologist
b. 1897, West Hartford, Connecticut
Associate professor of bacteriology and immunology at Harvard Medical School, Enders developed new and more economic means of tissue culture *in vitro* for the investigation of the virus of poliomyelitis and the large-scale preparation of a

suitable vaccine. With his principal collaborators (Thomas H. Weller, *b.* 1916, Michigan, also of Harvard; Frederick C. Robbins, *b.* 1916, Alabama, of Cleveland) he won the Nobel prize for medicine and physiology for 1954.

Fermi, Enrico, *d.* 1954 (see col. 158)

Fleming, Sir Alexander
d. in London, March 11, 1955
(see col. 164)

Hench, Philip Showalter
American physician
b. 1896, ~~Virginia~~
Hench graduated from Lafayette College (Easton, Pa.) and studied medicine in U.S.A. and Germany. He has been associated with the Mayo Clinic (Rochester) since 1921, as head of the department of rheumatic diseases since 1926. His contribution to the discovery of *cortisone* brought him a share of the Nobel prize for medicine in 1950 (with Kendall and Reichstein).

Keith, Sir Arthur, d. 1955
(see col. 251)

Krebs, Hans Adolf
German-British physiologist
b. 1900, Hildesheim
After qualifying in medicine at Hamburg and holding appointments in Berlin and Freiburg, Krebs, son of a Jewish doctor, left Germany in 1933, and eventually became professor of biochemistry at Sheffield University in 1945. His researches into metabolic processes, notably the 'citric acid cycle' (Krebs cycle), were recognised by the Nobel award for physiology and medicine 1953 (jointly with Lipmann).

Kusck, Polykarp
American physicist
b. 1911, Blankenburg, Germany
After carrying out research work at the

universities of Illinois and Minnesota and at the Bell telephone laboratories, he joined the staff of Columbia University, where he became professor of physics in 1949. He shared with Lamb J. L., the 1955 Nobel award for physics for his precision, determination of the magnetic movement of the electron.

Lamb, Willis Eugene
American physicist
b. 1913, Los Angeles
A graduate of California University, he joined the staff of Columbia University in 1938 and became professor of physics in 1948. In 1951 he took the chair of physics at Stanford University and in 1955 shared the Nobel award for physics with Kusch (q.v.) for his researches into the hydrogen spectrum.

Lipmann, Fritz Albert
German-American biochemist
b. 1899, Königsberg
Lipmann took refuge in the U.S.A. in 1939 and, after holding various appointments, became professor of biochemistry at Harvard in 1949. He has done notable work on the vitamin-B complex; his discovery of 'coenzyme A' brought him a Nobel prize for physiology and medicine for 1953 (with Krebs).

Martin, Archer John Porter
British biochemist
b. 1910, London
Working first at Cambridge and later in Leeds at the laboratories of the Wool Industries Research Association, Martin and R. L. M. Synge (see below) developed the technique of paper chromatography now widely used for analysis purposes in chemistry and jointly obtained the Nobel prize for chemistry in 1952.

McMillan, Edwin Mattison
American physical chemist
b. 1907, California
Educated first at the California Institute of Technology, professor of physics at

the University of California from 1946, McMillan received (with Seaborg) the 1951 Nobel award for chemistry for his part in the discovery of the transuranic elements.

Pauling, Linus Carl

American chemist

b. 1901, Portland, Oregon

Pauling was educated at the Oregon State College (Cornwallis) and the California Institute of Technology, at which, following a period of study in Europe (where he was much influenced by the leading quantum physicists), he has held important posts, including the professorship of chemistry since 1931. His researches into the nature of chemical bonds (set forth in his well-known book of that name, 1939) brought him universal renown and the Nobel prize for chemistry in 1954; but his fundamental contributions to chemical theory include much else—crystal structure, protein analysis, immunochemistry, etc. He won the Willard Gibbs medal in 1946 and the Davy Medal in 1948.

Penney, Sir William George

British atomic weapons physicist

b. 1909, Sheerness, Kent

Penney's early work, much of it concerned with molecular physics, was done at Imperial College, University of Wisconsin, and Cambridge. He lectured in mathematics at Imperial College, then during the Second World War undertook defence research for the Ministry of Supply. He was at Los Alamos in 1944-45 and supervised the Montebello test in 1952, becoming Director of Atomic Weapons Research in 1953. He was knighted in 1952.

Powell, Cecil Frank

British physicist

b. 1903, Tonbridge, Kent

Educated at Cambridge, where he studied under C. T. R. Wilson, Powell worked

next at Bristol, where he became professor of physics in 1948. His distinctive contribution has been his method for photographic study of nuclear processes, leading to his verification of the π -meson (see Yukawa). He received the Nobel physics prize for 1950.

Purcell, Edward Mills

American physicist

b. 1912, Taylorville, Illinois

Educated at Purdue University (Lafayette, Indiana) and Karlsruhe, Purcell has been associated since 1935 with Harvard, where he became professor of physics in 1949. His work on magnetic moments of atomic particles brought him the Nobel physics prize for 1952 (shared with Bloch).

Reichstein, Tadeusz

Swiss chemist

b. 1897, Poland

Educated mainly in Zurich, where he assisted Ružička and Staudinger and eventually became professor of organic chemistry at the Technical High School, Reichstein has taught at Basel since 1938, becoming head of the organic chemistry department in 1946. He has done outstanding work on the adrenal hormones, and received (with Kendall and Hench) the Nobel award for medicine in 1950.

Salk, Jonas Edward

American physician and virologist

b. Oct. 28, 1914, New York City

Salk qualified in medicine at New York University (M.D., 1939) and became prominent in virus research first at the University of Michigan, then (from 1947) at the University of Pittsburgh, where he became professor of bacteriology in 1949. His efforts to produce an anti-poliomyelitis vaccine (cultivated *in vitro* on minced monkey kidney tissue) were announced in 1955 to have been largely successful in respect of certain types of virus prevalent in U.S.A.

Soddy, Frederick, d. 1956
(see col. 413)

Staudinger, Hermann
German chemist
b. 1881, Worms

Staudinger held chemical teaching posts at Karlsruhe and Zurich before becoming professor of organic chemistry at Freiburg (1926-51). His research in macromolecular chemistry, with its far-reaching results on the development of plastics, brought him a belated Nobel award for chemistry in 1953.

Synge, R. L. Millington
British chemist
b. 1914, Liverpool

See Martin (A. J. P.) above.

Theiler, Max
South African bacteriologist
b. 1899, Pretoria

Educated in Cape Town and London, Theiler went to the Harvard Medical School in 1922, later to the Rockefeller Foundation, of which he became Director of Laboratories in 1951. His classic work confected with yellow fever immunization brought him the Nobel award for medicine in 1951.

Theorell, Axel Hugo Theodor
Swedish biochemist
b. 1903, Linköping

He studied medicine, but a crippling attack of poliomyelitis prevented him from practising as a doctor, and he took up research and teaching, becoming in 1930 assistant professor of chemistry at Uppsala. Since its foundation in 1935 he has been director of the Nobel Institute of Biochemistry at Stockholm. As a blood specialist he won renown for his work on myoglobin, and was awarded the 1955 Nobel prize for medicine for his discoveries concerning the nature and action of oxidation enzymes.

Zernicke, Fritz
Dutch physicist
b. 1888, Amsterdam

Zernicke, professor of physics at Groningen, has ranged widely in his researches, but is known chiefly for his development of the phase-contrast principle in optics, now of great importance in microscopy. He received the Nobel physics prize in 1953 and in 1952 the Rumford Medal of the Royal Society, of which he became a Fellow in 1956.

Chambers's DICTIONARY OF SCIENTISTS

Abbe, Cleveland

American meteorologist

b. Dec. 3, 1838, New York

d. 1916

Educated at Harvard, Abbe held posts in the U.S. Naval and Cincinnati observatories as well as being for some time chief meteorologist in the U.S. weather bureau. He was a writer of scientific books which included works on the atmosphere, and climate in relation to crops, and he was responsible for the introduction of the system of Standard Time.

Abbe, Ernst

German physicist

b. Jan. 23, 1840, Eisenach, Thuringia

d. Jan. 14, 1905, Jena

Educated at Göttingen and Jena, Abbe became professor at the University of Jena in 1870, and in 1878 the director of the astronomical and meteorological observatories. He was a partner in the optical works of Carl Zeiss, on whose death he became owner in 1888. Famous for his researches in optics, he was the inventor of an arrangement known as Abbe's homogeneous immersion, in which the object and the lower face of the microscope objective are immersed in cedar oil of the same refractive index as the lens glass. This gives a very high magnification. He also invented an achromatic microscope objective. See F. Auersbach, *Ernst Abbe* (1918).

Abbot, Charles Greeley

American astrophysicist

b. May 31, 1872, Wilton, N.H.

Educated at the Massachusetts Institute of Technology, Abbot became director of the observatory at the Smithsonian Institution. He is noted for his work on solar physics, and in particular for his investigation with Langley of the infra-red spectrum, and for his work on the variability of the sun. He was awarded the Draper and Rumford medals in 1910 and 1916 respectively. He is the author of *The Sun* (1907) and *The Earth and the Stars* (1925).

Abegg, Richard

German chemist

b. 1869, Danzig

d. 1910

Educated at Tübingen and other universities, Abegg became assistant at Göttingen in 1894, and later professor of chemistry. In 1909 he occupied a similar position at Breslau. Between 1894 and 1898 he worked on the freezing points of solutions and the dielectric constant of ice, and in 1899 with Bodländer he put forward a theory of valency.

Abel, Sir Frederick Augustus

English chemist

b. July 17, 1827, Woolwich

d. Sept. 6, 1902, London

After studying under Hofmann at the Royal College of Chemistry, Abel became professor of chemistry at the Royal Military Academy in 1851, and was chemist to the War Department, and government adviser on chemicals. He was an authority on the chemistry of explosives and also an expert on the manufacture of steel. With Dewar

ABEL

he invented cordite and his work prepared the way for smokeless powder. He constructed the Abel tester, for the determination of the flash-point of petroleum.

Abel, John Jacob
American physiological chemist
b. May 19, 1857, Cleveland, Ohio
d. May 26, 1938

Educated at Michigan and the Johns Hopkins University, Abel studied medicine in Europe before becoming professor of physiological chemistry at the latter university until retirement in 1932. Famous for his investigations of animal tissues, he did work on the suprarenal glands which was outstanding. In the course of this investigation he isolated epinephrine (adrenalin), the constituent in these glands responsible for the rise of blood pressure. Takamine and Aldrich had also isolated this substance (1901). Abel was awarded the Willard Gibbs medal in 1927.

Abel, Niels Henrik
Norwegian mathematician
b. Aug. 25, 1802, Findöe
d. Apr. 6, 1829, nr. Arendal, Agder
Educated at Christiania (Oslo), Abel became one of the most famous analysts of his time. His premature death was a great loss to mathematics. His most famous work was in connection with the theory of elliptical functions, and his collected works were published by the Swedish government in 1839. See Lucas de Peslouän, *Niels Henrik Abel* (1906).

Abetti, Antonio
Italian astronomer
b. June 19, 1846, Gorizia
d. Feb. 20, 1928
Educated at Pisa, Abetti worked in the observatory there and eventually became director of the Arcetri Observatory in Florence. He was an authority on the minor planets.

Abich, Otto Wilhelm Hermann von
German geologist
b. Dec. 11, 1806, Berlin
d. July 1, 1886, Vienna

After studying mineralogy in Berlin, Abich became professor at Dorpat and was also noted for his explorations in Asia Minor. He worked on spinels, fumaroles and volcanic problems. The mineral clinoclase (basic copper arsenate) was originally named Abichite after him. He wrote *Geologische Forschungen in den Kaukasischen Ländern* (1878-87).

Abney, Sir William de Wiveleslie
English chemist
b. July 24, 1843, Derby
d. Dec. 3, 1920, Folkestone
A former President of the Royal Astronomical Society and of the Physical Society, Abney was noted for his researches in photographic chemistry, colour photography and printing. In 1880 he succeeded in photographing the infra-red solar spectrum as far as 11,000 angstroms, and he devised a method for the measurement and classification of colours by determining the relative proportions of the primaries in the colour under test.

Achard, Franz Karl
German chemist
b. April 28, 1753, Berlin
d. April 20, 1821, Kunern, Silesia
Following on Marggraf's discovery of sugar in beetroot, Achard invented a process for the extraction of the sugar, and in 1801 opened the first sugar-beet factory, in Silesia. He was the first, in 1784, to prepare a platinum crucible.

Acheson, Edward Goodrich
American chemist and inventor
b. Mar. 9, 1856, Washington, Pa.
d. July 6, 1931
Working under Edison, Acheson did pioneer work in the development of the electric furnace for the production of silicon carbide and graphite. He evolved the lubricants, Oildag, Aquadag and Gredag, colloidal dispersions of graphite.

Adam, Neil Kensington
English physical chemist
b. Nov. 5, 1891, Cambridge
Educated at Winchester and Trinity College, Cambridge, Adam worked at

Sheffield and London before becoming professor of chemistry at Southampton in 1937. Continuing Langmuir's work (1917) on surface films, he worked from 1920 to 1939 on unimolecular surface films on water. This revealed, at the water-air boundary surface, the existence of a two-dimensional state of matter which can exist in various phases, closely analogous to solid, liquid and gaseous states in three dimensions; much light has also been shed on the sizes, shapes, and fields of force round molecules of organic substances. He has published, among other papers, *The Physics and Chemistry of Surfaces* (1930, 1938 and 1941).

Adams, John Couch

English astronomer

b. June 5, 1819, Lamez, Cornwall

d. Jan. 21, 1892, Cambridge

Educated at Cambridge, Adams became senior wrangler there in 1843 and after being professor of mathematics at Aberdeen in 1858, he became Lowndean professor of astronomy and geometry at Cambridge in 1859. His fame rests upon the fact that both he and Leverrier in France worked out the position of the then undiscovered Neptune by calculations based on the irregularities of the orbit of Uranus. Though Adams reached his conclusions first, his results were allowed to lie unchecked, until Galle of Berlin working on Leverrier's results was able to announce the discovery of the new planet in 1846. After some controversy it was decided that the two mathematicians should share the credit. In 1867 Adams also determined the orbit of the Leonids, a November shower of meteorites, showing from theory which out of five possible orbits was the correct one. He also did important work on terrestrial magnetism, gravitational astronomy and on the secular acceleration of the moon's mean motion.

Adams, Walter Sydney

American astronomer

b. Dec. 20, 1876, Antioch, N. Syria

Educated at Dartmouth, Chicago and Munich, Adams worked at the Yerkes observatory before becoming director of



JOHN COUCH ADAMS

the Mount Wilson observatory in 1923. He discovered that the intensities of certain lines in stellar spectra depend on the absolute luminosities of the stars. This gave him a method of measuring the distances of hundreds of stars by means of the spectroscopic. In addition he wrote a memoir on the rotation of the sun.

Adanson, Michel

French naturalist

b. April 7, 1727, Aix-en-Provence

d. Aug. 3, 1806

A French traveller of Scottish descent, Adanson wrote works on botany, and in particular a natural history of Senegal. The name Adansonia has been given to the baobab genus (Monkey-bread tree). In 1743 he classified plants under a new system in *Les Familles Naturelles des Plantes*.

Addison, Thomas

English physician

b. April, 1793, Long Benton, nr. Newcastle-on-Tyne

d. June 29, 1860, Lanercost, Cumberland

ADLER

Trained in medicine at Edinburgh, Addison set up practice in London and became physician to Guy's Hospital. He was an authority on anaemia which he divided into two types, one being now known as pernicious anaemia and the other (progressive destruction of the suprarenal cortex) as Addison's disease. He also wrote a text-book with Bright in which he described inflammation of the appendix vermiciformis, though the disease was not then well-known.

Adler, Alfred

Austrian psychologist

b. Feb. 7, 1870, Vienna

d. May 28, 1937, Aberdeen

At first a follower of Freud, Adler seceded in 1911 from the Freudian School by maintaining that will-to-power (self-assertion) is more important in human behaviour than sex-impulse. He introduced the idea of inferiority complex and regarded the unconscious as largely suppressed and forgotten personal experience. In 1929 he left Vienna for a professorship in New York. With Freud and Jung he raised psychology to a new level. Among his books were *Theory and Practice of Individual Psychology* (1918) and *Pattern of Life* (1930).

Adrian, Edgar Douglas

English biologist

b. Nov. 30, 1889, London

Educated at Cambridge and Bartholomew's, Adrian became a research professor of the Royal Society in 1929 and professor of physiology at Cambridge in 1937. Elected F.R.S. in 1923, he was awarded the Copley medal in 1946, having shared with Sherrington the Nobel prize for medicine in 1932 for work on the functions of the neurons. He is one of the most brilliant living investigators of the nervous system, publishing many books and papers on the subject, including *The Physical Basis of Perception* (1947). His work on 'brain waves', first investigated by Berger, brought the subject to the fore, and he was one of the first to realise the enormous importance of this means of research.

Africanus, Sextus Julius

Traveller and historian

b. c.150, Libya

The writer of a history of the world from 5499 B.C. to 221 A.D., Africanus is also credited with a book dating from near the end of the second century, in which were given among other things the method of finding the breadth of a river from one side, and how to signal with a semaphore. His chronology which antedates Christ's birth by 3 years was accepted by many Eastern churches.

Agardh, Karl Adolf

Swedish botanist and mathematician

b. Jan. 23, 1785, Bastad

d. Jan. 28, 1859, Karlstad

Educated at Lund, Agardh became lecturer there in mathematics and later professor of botany and rural economy. He abandoned science for religion and became a bishop in later life. He was the writer of a book, *Systema Algarum*, in which he gave a description of forty-nine diatoms, the first account of diatoms (1824).

Agassiz, Jean Louis Rodolphe (Louis)

Swiss-American naturalist

b. May 20, 1807, Motier, Murtensee.

d. Dec. 12, 1873, Cambridge, U.S.A.

After studying medicine at Zürich, Heidelberg and Munich, Agassiz became professor of natural history at Neuchâtel. He took degrees at Erlangen and Munich and later went to America and taught at Harvard and Cornell Universities. He was an authority on ichthyology and the writer of some famous books on the subject in which he proposed a new classification of the fishes. From the characteristics of the skin he divided them into four classes, ganoids, placoids, cycloids and ctenoids. Though his system has not been adopted the names have been found useful. He was a strong opponent of the theories of Darwin.

Agassiz, Alexander Emanuel

American naturalist

b. Dec. 17, 1835, Neuchâtel

d. Mar. 27, 1910, at sea

The son of Louis Agassiz, and educated at

Harvard, Agassiz was trained as an engineer. As assistant in the U.S. coast survey, he constructed new apparatus for the exploration of the ocean bed. He demonstrated that the deep-sea animals of the Caribbean are similar to those of the Pacific, and suggested that it was a bay of the Pacific which was cut off in Cretaceous times by the rise of the Panama Isthmus to form the Caribbean Sea.

Agricola, Georgius (Georg Bauer)

German physician

b. Mar. 24, 1490, Saxony

d. Nov. 21, 1555, Chemnitz

Trained first in philology and then medicine, Agricola became a physician at Joachimstal. This being a mining and smelting centre, he was able to pursue that interest in ores and mining which was to gain him regard as the founder of scientific mineralogy. He wrote several books on this subject and on metallurgy. The best known and popular *De re metallica, libri xii* (1556) was one of the first treatises on applied chemistry.

Airy, Sir George Biddell

English astronomer

b. July 27, 1801, Alnwick, Northumberland

d. Jan. 2, 1892, Greenwich

Educated at Cambridge, Airy became senior wrangler there in 1823. After being professor of mathematics he became professor of astronomy there and director of the new observatory. He was Astronomer Royal from 1835 to 1881. He is noted for his discovery of a new inequality in the motions of Venus and the Earth. He determined the mass of the earth by measuring the value of 'g' with a pendulum at the top and bottom of a coal-mine (Harton, near Sunderland). Airy's spirals are a phenomenon which he discovered, connected with the polarisation of light through quartz crystals.

Aitken, John

Scottish physicist

b. 1839, Falkirk

d. Nov. 13, 1919, Falkirk

A fellow of the Royal Society, Aitken did

much work on the atmosphere, and devised a method of measuring its dust content. He discovered that if compressed air containing dust particles is allowed to expand suddenly, a cloud is formed, the dust acting as nuclei for the drops. Thus there is practically no mist in clean air. This explains some instances of fog-formation, but it has been shown since that ionised gaseous particles can act as nuclei also. He also demonstrated that in most cases dew formed on plants is exudation, unevaporated because of the fall in temperature of the air.

Albertus Magnus, Saint, Count of

Bollstadt (Albert of Cologne)

German scholar

b. 1193 (1206 ?), Lauingen, Bavaria

d. 1280, Cologne

After studying at Padua, Albertus entered the Dominican Order and held the Bishopric of Ratisbon from 1260-62, gaining the appellation *Doctor Universalis* and a great reputation as a Christian scholar. He relinquished office, however, to devote himself to study, and wrote many books on theology, physics and natural history, much in the spirit of Aristotle. He criticised the alchemists, did not believe in the transmutation of metals, and was the first to use the word *affinity* in the sense of chemical relation. Some give him the credit of being the first to isolate metallic arsenic. He constructed an automaton in the form of a figure which opened doors.

Albuzjani (Abul-Wafa)

Persian mathematician

b. 940

d. 998

One of the first writers on trigonometry, Albuzjani was responsible for the introduction of some trigonometrical functions. He also drew up tables of tangents and cotangents.

Alcmaeon

Greek scientist

c. 500 B.C.

A physician who lived at Croton in Southern Italy, Alcmaeon is recognised

ALDROVANDI

as the real discoverer of the Eustachian tube, which connects the cavity of the eardrum to the mouth. Also he may be regarded as the founder of embryology as he was probably the first to study the development of the chicken in an incubated egg. He held the strange belief that goats breathe through their ears.

Aldrovandi, Ulijsi

Italian naturalist

b. 1522, Bologna

d. 1605, Bologna

Educated at Bologna and Padua, and at one time imprisoned for heresy, Aldrovandi became professor of natural history at Bologna in 1560. He was the founder and director of the botanical gardens there and wrote a famous natural history which was notable for its illustrations.

Alembert, Jean le Rond d'

French mathematician and philosopher

b. Nov. 1717, Paris

d. Oct. 29, 1783, Paris

An illegitimate child, d'Alembert was abandoned at the church of St. Jean le Rond (hence his name). His parents, the Chevalier Destouches and Mme de Tencin, though not publicly acknowledging him, gave him a yearly income and he was brought up by the wife of a poor glazier. These difficulties could not prevent his rise to fame as a mathematician. His work on dynamics was especially well-known, and his calculus of partial differences has proved its value in mathematical physics. D'Alembert's principle is a very useful device for the application of statical rules to dynamical problems. He added much to Newton's work on the motion of the heavenly bodies and also to our knowledge of the precession of the equinoxes, and he wrote works on literature, history and philosophy. His general outlook was materialistic.

Alhazen

Arab mathematician

b. (?) 967, Bassora (Basra)

d. 1038, Cairo

Alhazen was the writer of a work on optics, *Opticae thesaurus Alhazeni, libri vii*

(in Latin, 1572), which became a standard work in the Middle Ages. This included the first scientific account of atmospheric refraction, and problems on reflection from concave surfaces. He had a remarkable knowledge of his subject, and opposed the normal conception of vision as rays passing from eye to object. He constructed both spherical and parabolic mirrors and was aware of most of the problems inherent in their use. Part of his life was spent in pretended madness to avoid being called upon by the calif Hakim to fulfil a boast that he could build a machine to control the flooding of the Nile. The 10th century translator of Ptolemy's *Almagest* was another of the same name.

Allbutt, Sir Thomas Clifford

English physician

b. July 20, 1836, Dewsbury, Yorks

d. Feb. 22, 1925, Cambridge

Educated at Cambridge, Allbutt studied medicine at London and Paris. After practising for thirty years in Leeds he became Regius Professor of Medicine at Cambridge. In 1867 he invented the short clinical thermometer in place of the old one, a foot long, which had taken twenty minutes to register the temperature. He also did important work on tetanus and hydrophobia, and was an authority on the heart.

Allison, Fred

American physicist

b. July 4, 1882, Glade Spring, Va.

Educated at Columbia and Chicago Universities, Allison became professor of physics at Alabama Polytechnic Institute in 1922. He discovered the magneto-optic method for the detection of isotopes which led to the recognition of sixteen isotopes of lead, and he also announced the discovery of element 87 (francium) in 1930, and of element 85 (astatine) in 1931.

Allmand, Arthur John

English chemist

b. 1885, Wrexham

After studying at Liverpool, Karlsruhe and Dresden, Allmand became professor of chemistry at King's College, London, in

1919. He was elected F.R.S. in 1929 and is noted for his researches in electrochemistry and photochemistry. He published *Principles of Applied Electrochemistry* (1912 and 1924).

Alter, David

American physicist
b. 1807, Freeport, Pa.
d. 1881

A physician and inventor as well as a physicist, Alter was one of the earliest investigators of the spectrum. In 1854 he showed that each element had its own spectrum, conclusively proved a few years later by Bunsen and Kirchhoff in their pioneer research on the Fraunhofer lines. He also forecast the use of the spectroscope in the domain of astronomy.

Amici, Giovanni Battista

Italian biologist
b. Mar. 25, 1786, Modena
d. April 10, 1863, Florence

An astronomer and professor of mathematics as well as a biologist, Amici was the inventor in 1840 of an immersion system for microscopes, and he also effected improvements in the mirrors of reflecting telescopes. He did important work on the sexual character of flowers, his observations of the pollination of orchids being an especially valuable clarification of the subject.

Ampère, André-Marie

French mathematician and philosopher
b. Jan. 22, 1775, Polémieux, nr. Lyons
d. June 10, 1836, Marseilles

Ampère's early bent for mathematics had to survive the severe tests of seeing his father executed by the Jacobins, when he was 18, and of subsequent money difficulties during his early manhood. Nevertheless he rose to be professor of mathematics at the Polytechnic School, Paris, and professor of physics at the Collège de France. Carrying on experiments in his flat in poverty, he enunciated all the laws of force between a magnet and a constant electric current and outlined the theory, all in a few weeks. He is regarded as the founder of the science of electro-dynamics

and his name is perpetuated in the unit of current.

Anaxagoras

Greek philosopher
b. 498 B.C., Clazomenae, Ionia
d. 428 B.C., Lampsacus

A teacher at Athens whose pupils included Pericles, Euripedes and Socrates, Anaxagoras was one of the so-called atomic school of philosophers. The atomists believed that bodies are composed of indivisible (Gk. *atomos*) particles or atoms and that there is an infinite number of elementary atoms. Anaxagoras believed in a small sun, and a flat earth, and supposed the comets to be wandering stars. He considered the ordering of atoms the result of pure infinite Mind (*nous*), a step towards theism which influenced Socrates. At the age of fifty he was charged with impiety and sentenced to death, but was sent into banishment instead.

Anaximander

Greek philosopher
b. 611 B.C., Miletus, Ionia
d. 547 B.C.

Although he held some peculiar views regarding astronomy, Anaximander is credited with the invention of geographical maps, and the first application of the horizontal gnomon to the determination of the solstices and equinoxes. He regarded the sun, moon and earth as cylinders, the sun having a circumference twenty-eight times that of the earth, and the moon nineteen times. He evolved the notion of the infinite (*to apeiron*) as the principle underlying phenomena, and postulated a never-ending motion of opposites, beginning in and reverting to the infinite. Human life arose by some sort of evolutionary series from a form of aquatic activity.

Anderson, Carl David

American physicist
b. Sept. 3, 1905, New York

Educated at the Californian Institute of Technology, Anderson became professor of physics there in 1939. Noted for his research on gamma and cosmic rays, and

ANDERSON

for his discovery of the positron in 1932, independently of Blackett, he received the Nobel prize for physics with Hess in 1936. In 1938 he and Neddermeyer obtained experimental evidence of the existence of the meson.

Anderson, Elizabeth Garrett

English physician

b. June 9, 1836, London

d. Dec. 17, 1917, Ipswich, Suffolk

Educated privately, Elizabeth Garrett struggled hard to obtain the necessary qualifications to practise as a doctor, as the existing schools of medicine were strongly opposed to the entry of women. Despite this opposition Elizabeth Garrett (Anderson by marriage) obtained the degree of Doctor of Medicine at Paris and became lecturer in medicine to the London School of Medicine for Women. She did pioneer work in opening up the medical profession to women and was also the first woman mayor (of Aldeburgh) in England. As might be expected she took a prominent part in the women's suffrage movement. See Dame Millicent Fawcett, *What I Remember* (1924).

Anderson, Thomas

Scottish organic chemist

b. 1819

d. Nov. 2, 1874

Educated at Edinburgh in medicine, Anderson studied further at Stockholm, Giessen and other continental universities before becoming professor of chemistry at Glasgow. He is remembered as the discoverer of pyridine, and other constituents of bone oil. He also did research on the constitution of anthracene, and a great deal of work on agricultural chemistry.

Andrade, Edward Neville da Costa

English physicist

b. Dec. 27, 1887, London

After studying at London, Heidelberg, Cambridge and Manchester, Andrade became professor of physics at Woolwich, and in 1928 occupied a similar chair in London University. He was elected F.R.S. in 1935, and is well-known for his work on atomic structure. He became director of the Royal Institution and the Davy-Fara-

day laboratory in 1950. His books include *The Structure of the Atom* (3rd ed. 1927).

Andrews, Thomas

Irish chemist

b. Dec. 19, 1813, Belfast

d. Nov. 26, 1885, Belfast

After studying chemistry at Glasgow and Paris, and medicine at Edinburgh, Andrews remained professor of chemistry at Belfast from 1849 to 1879. He is famous for his discovery that every gas has a critical temperature above which liquefaction is impossible, and also for his work on ozone and the heat of chemical combustion.

Ångström, Anders Jonas

Swedish physicist

b. Aug. 13, 1814, Lögö, Medelpad

d. June 21, 1874, Uppsala

Educated at Uppsala, Ångström became professor of physics there in 1858 and is noted particularly for his work on spectroscopy. His name has been given to the unit by which we measure wavelength in the spectrum. The angstrom, which was first defined as 10^{-8} cm., is now regarded as a definite fraction of the wavelength of the red cadmium line, so that the length of the metre depends on this too. ($100,000,000 \text{ A.U.} = 1 \text{ cm.}$). He published a famous map of the normal solar spectrum, discovering hydrogen in the solar atmosphere, and was the first to examine the spectrum of the aurora borealis.

Ångström, Knut Johan

Swedish physicist

b. Jan. 12, 1857, Uppsala

d. Mar. 4, 1910, Uppsala

The son of Anders Jonas, Ångström became professor of physics at Uppsala in 1896. He is noted for his invention of an electric compensation pyrheliometer (1893) and other apparatus for the photography of the infra-red spectrum. He investigated the radiation of heat from the sun.

Apollonius, of Perga, 'The Great Geometer'

Greek mathematician

b. c. 260 B.C.

d. c. 200 B.C.

One of the Alexandrian School, Apollonius

ARCHIMEDES

wrote a famous book on conic sections which not only summarised all the known facts but added immensely to them and left very little to be discovered. He introduced the terms *parabola*, *ellipse* and *hyperbola*.

Appleton, Sir Edward Victor

English physicist

b. Sept. 6, 1892, Bradford

Educated at Cambridge, Appleton became demonstrator in the Cavendish Laboratory before moving first to London as professor of physics, and then back to Cambridge as professor of natural philosophy. In 1939 he became secretary to the Department of Scientific and Industrial Research, and in 1948 became Principal and Vice-Chancellor of the University of Edinburgh. He was elected F.R.S. in 1927 and was awarded the Nobel prize for physics in 1947 for his work on the atmosphere. He is particularly noted for his work in connection with the development of radar, and his name has been attached to a layer which he discovered in the upper atmosphere, the *Appleton layer*, an ionised region which acts as a reflector of radio waves.



SIR E. V. APPLETON attends a reception in honour of his Nobel award.

Arago, Dominique François Jean

French physicist

b. Feb. 26, 1786, Estagel, Perpignan

d. Oct. 2, 1853, Paris

Beginning his career as a secretary at the Bureau de Lorgitude, Arago went with Biot to Spain in 1806 to complete the measurements of Delambre and Méchain of an arc of the meridian. The return journey was not lacking in incident as the ship was wrecked and he was almost enslaved at Algiers. He made distinguished researches in many branches of physics, and in 1838 suggested the means by which a rotating mirror could be used in the determination of the velocity of light. He showed with Fresnel that the results of experiments on diffraction confirmed the wave theory of light, and was the first to discover that other substances than iron have magnetic properties. For this he received the Copley medal in 1825. He worked on the velocity of sound from 1818 to 1822, and also discovered the production of magnetism by electricity.

Archimedes

Greek physicist and mathematician

b. c. 287 B.C., Syracuse, Sicily

d. c. 212 B.C., Syracuse

The son of an astronomer, Archimedes studied at Alexandria and was the only one of the ancients to develop accurate theories in mechanics and hydrostatics. He was the discoverer of the famous principle named after him, which states that an immersed body suffers an apparent loss in weight equivalent to the weight of liquid displaced. This was reputed to have been the result of thought upon the problem of how to test the purity of the gold in King Hiero's crown, to which too much alloy had been fraudulently added. Archimedes is supposed to have reached his conclusion while bathing, upon which in his excitement he ran home undressed shouting 'Eureka! eureka!' He was familiar with levers, and is supposed to have said that if he had a fulcrum he could move the world. Among his inventions are the compound pulley, the Archimedean screw and probably the endless screw. When the Romans besieged Syracuse it is said that

ARCHYTAS

he set their ships on fire with burning glasses (concave mirrors), and tradition relates that he was killed by the Romans, who came upon him studying a mathematical problem in the sand of the market place. In geometry he wrote treatises on spheres, conoids and spirals, and investigated the relationships between the circumference, diameter and area of a circle.

Archytas

Greek mathematician

b. c. 428 B.C., Tarentum, Southern Italy

d. c. 347 B.C.

Governor of the city of Tarentum seven times, Archytas was a liberal thinker noted for his humanitarian outlook. He was drowned in a shipwreck. He is credited with the invention of the pulley, and with the construction of a flying bird, and is also supposed to have invented the analytic method in mathematics. He was the first to distinguish harmonic from arithmetical and geometrical progressions, and contributed to the theory of acoustics.

Arduino, Giovanni

Italian geologist

b. 1713

d. 1795

The Director of Mines in Tuscany, Arduino later became professor of mineralogy at Padua. In 1760 he made the first classification of the younger rocks as Primary, Secondary and Tertiary, part of which classification has since been abandoned and part modified.

Areteaus

Greek physician

c. 2nd century, Cappadocia

A follower of Hippocrates and a clear writer, Areteaus worked in Rome, and was the first to name the disease diabetes, and also the first to distinguish between spinal and cerebral paralysis.

Arfwedson, Johan August

Swedish chemist

b. 1792, Skagerholms-Bruk

d. 1841, Hedenso

Educated privately and then at Uppsala, Arfwedson became secretary at the Royal

Bureau of Mines at Stockholm. In 1817, while working in the laboratory of Berzelius in Stockholm, he discovered some compounds of lithium. He was unable to isolate the metal owing to the weakness of the voltaic pile which was available. Davy was the first to succeed in this. Arfwedson owned several manufactories and mines which caused him later to abandon almost all his scientific research.

Argand, Aimé

Swiss chemist

b. 1755, Geneva

d. Oct. 24, 1803

The inventor (1782-84) of the well-known oil burner named after him, Argand made the wick in the form of a ring or hollow cylinder covered by a chimney, inducing a current of air both inside and out.

Argand, Jean Robert

Swiss mathematician

b. 1768, Geneva

d. 1822, Paris

One of the first to use complex numbers, Argand employed them to show that all algebraic equations have roots. The *Argand diagram* represents a complex number (the sum of a real and an imaginary number) by a point of which the unit of measurement along the y (or imaginary) axis is i ; sometimes written as $re^{i\phi}$ where $r = \sqrt{(x^2 + y^2)}$, and $\phi = \tan^{-1}(y/x)$.

Argelander, Friedrich Wilhelm August

German astronomer

b. Mar. 22, 1799, Memel

d. Feb. 17, 1875, Bonn

Argelander was educated at Königsberg and became professor of astronomy at Bonn in 1837. He studied the motion of the solar system in space, and published a catalogue of 576 stars with proper motion. His main star catalogue contained 324,198 stars. He also introduced the decimal division of stellar magnitudes, thus laying the foundation of accurate stellar photometry.

Aristarchus

Greek astronomer

b. 310 B.C.

d. 250 B.C.

A resident of Samos, Aristarchus is regarded as the inventor of the hemispherical sun-dial. He was also the first to assert the revolution of the earth about the sun, an idea which was not accepted at the time though it gave a simple explanation of many phenomena. He measured the distances and sizes of the sun and moon and recognised that 365 $\frac{1}{4}$ days was only an approximation for the length of the year, adding a correction of 1/1623 of a day.

Aristotle

Greek philosopher and naturalist

b. 384 B.C., Stagira

d. 322 B.C., Chalcis

One of the most famous of the Greek philosophers, Aristotle was the son of the physician to the King of Macedonia. Orphaned at seventeen, he came to Athens to study under Plato, and remained with him twenty years, in fact up to Plato's death in 348 B.C. He later became tutor to Alexander the Great who was fourteen years old at the time, and after instructing him for five or six years he remained as his friend and counsellor until 334 B.C. It was then that he established the Peripatetic School in Athens, supposed to be so named because he taught whilst walking up and down in the Lyceum. In this period he wrote many books on biology, natural science, ethics, logic, metaphysics, politics and literature, but the death of Alexander caused his retirement and he died shortly afterwards. His works were first printed in Latin in 1489 and in Greek in 1495. In the scientific aspects of his teaching, which were secondary in importance to his philosophical, ethical and political speculation, he was the first to suggest the alternation of land and sea areas in the earth's geological development, i.e. the cycles of mountain building and denudation which are now recognised phases of the earth's history. Aristotle held mistaken ideas on the origin of life, thinking that plant-lice arose from the dew which forms upon plants, and that fleas sprang from putrid matter. He was a pioneer of classification, being one of the first to attempt a classification of the animals, using

as a basis those with red blood and those without, and his work on marine animals was based on careful and extensive observation. He thought that the velocity of a falling body was proportional to its weight, a mistaken concept which was not disproved until Galileo's famous experiment. He also thought a vacuum to be impossible, and he considered that all substances were composed of a ~~primary~~ matter, in other words, that there is only one element. His scientific thought, though often misunderstood, exerted a tremendous influence on learning up to the 17th century.

Arkwright, Sir Richard

English inventor

b. Dec. 23, 1732, Preston

d. Aug. 3, 1792, Cromford, Derbyshire

The youngest of thirteen children, Arkwright was trained as a barber, but gave it up at the age of 35 to concentrate on inventions for cotton spinning. He improved on Hargreaves' jenny by inventing (about 1769) the spinning frame, which dealt with a very large number of threads at once. The contemporary riots against the introduction of machinery forced him to leave Lancashire for Nottingham, but despite troubles of this kind and also law-suits over patent rights he died a rich man.

Armstrong, William George, Lord

English engineer

b. Nov. 26, 1810, Newcastle-on-Tyne

d. Dec 27, 1900, Rothbury, Northumberland

Though trained in the law, Armstrong turned to invention, one of his earliest successes being the hydraulic crane. The Armstrong gun, his most remarkable production, introduced rifling in the barrel, breech loading, and reinforcement of the barrel by spirals of wrought iron. He established the great Elswick works near his home town.

Arnold, Joseph

English botanist

b. Dec. 28, 1782, Beccles, Suffolk

d. July, 1818, Padang, Sumatra

His medical studies at Edinburgh completed, Arnold became a doctor on a

ARNOTT

prison ship, and was later naturalist to Sir Stamford Raffles. While travelling with Raffles he had the distinction of discovering the largest flower known. *Rafflesia arnoldi* is a yard across, each petal being a foot in length; its weight is fifteen pounds and the nectarium holds twelve pints. It has neither leaves nor branches.

Arnott, Neil

Scottish scientist

b. May 15, 1788, Arbroath

d. Mar. 2, 1874, Edinburgh

Educated at Aberdeen, Arnott later studied medicine, and after practising in London, became the Queen's physician, being elected F.R.S. in 1838. He is well known for his invention of an economical stove and also his water-bed for use in cases of prolonged sickness. He published a text-book on physics which enjoyed great popularity, being translated into several languages and running to seven editions.

Arrhenius, Svante August

Swedish physicist and chemist

b. Feb. 19, 1859, Wijk, nr. Uppsala

d. Oct. 1, 1927, Stockholm

As a student at Uppsala and Stockholm,

Arrhenius showed extraordinary mathematical ability. After working with van't Hoff in Amsterdam he became professor of physics at Stockholm. In 1887 he established the theory of electrolytic dissociation for which he was awarded the Nobel prize for chemistry in 1903; he subsequently extended it to the phenomena of atmospheric electricity. He investigated also the viscosity of solutions and reaction velocity, and was interested in the structure of the universe, being, indeed, one of the first to appreciate light pressure and its part in cosmic physics, e.g., the repulsion of a comet's tail by radiation from the sun.

Arsonval, Jacques Arsène d'

French physicist

b. 1851, Borie

d. 1940

D'Arsonval was director of the laboratory of biological physics, Collège de France, from 1882, and became professor there in 1894. He is noted for his invention of the reflecting galvanometer with a moving coil, named after him; and also for his work on high-frequency oscillating current of high amperage and low voltage. This latter current he experimented with in connection with the electrical treatment of disease.

Arzachel

Arab astronomer

c. 11th century

With the exception of the fact that he was living in Toledo in 1080, little is known of Arzachel, but he made the interesting suggestion that the planets move in ellipses. This, however, none of his contemporaries would accept.

Aselli, Gasparo

Italian anatomist

b. 1581, Cremona

d. 1626, Milan

Aselli is noted for his discovery of lacteal vessels, made while he was professor of anatomy at Pavia. These vessels collect the fatty material from the food in the intestines and take it to the thoracic duct. Aselli's results, which were obtained from a study of dogs, were published in 1627 in *De Lactibus*.



SVANTE AUGUST ARRHENIUS

Astbury, William Thomas

English physicist

b. Feb. 25, 1898, Longton, Stoke-on-Trent
Educated at Cambridge, Astbury was assistant to Sir William Bragg at the Royal Institution before going to Leeds to become director of the Textile Physics Research Laboratory. He was elected F.R.S. in 1940. An expert on X-ray analysis, he is famous for his work on crystal structure, fibres and proteins.

Aston, Francis William

English physicist

b. Sept. 1, 1877, Harborne, Birmingham

d. Nov. 20, 1945

Educated at Birmingham and Cambridge, Aston became in 1920 a Fellow of Trinity College, in 1921 F.R.S., and in 1935 chairman of the International Committee on Atoms. He received the Nobel prize for chemistry in 1922 for his work on isotopes, in which field he was pre-eminent. He introduced in 1919 the mass-spectrograph, with which he was able to show that a large number of elements are isotopic; for example, he found eight isotopes of common lead, and determined the masses of several isotopes to an accuracy of one thousandth. *Isotopes* (1922) and *Mass-spectra and Isotopes* (1933) are his most important publications.

Atwood, George

English mathematician

b. 1746

d. July, 1807, Westminster

A Fellow and Tutor of Trinity College, Cambridge, and an F.R.S., Atwood is remembered as the inventor of a well-known machine named after him, used for verifying the laws of falling bodies, and described in his *Treatise on the Rectilinear Motion and Rotation of Bodies* (1784).

Auenbrugger (von Auenbrug), Leopold

Austrian physician

b. Nov. 19, 1722, Graz, Steyermark

d. 1809

The son of an innkeeper of Graz, Auenbrugger became physician to the military hospital of Vienna. Here he first used on his patients' chests the same technique



FRANCIS WILLIAM ASTON

as he had done on his father's wine barrels, tapping them and listening to the sound produced to form an opinion of the internal state of the cavities (percussion). In 1761 he published an account of his new help to diagnosis, but little notice was taken of his discovery for twenty years. See M. Neuburger, *Leopold Auenbrugger* (1922). See also Laennec.

Avebury, John Lubbock, Lord

English naturalist

b. Apr. 30, 1834, London

d. May 28, 1913, Kingsgate Castle, Kent

After leaving Eton, Avebury became a banker; he was, however, always interested in science, and became President of the Entomological and Anthropological Societies. He wrote many popular books on science, and was the first to mark bees individually so that their behaviour could be closely observed.

Avicenna

Arab physician and philosopher

b. 979, Kharmathen, nr. Bokhara

d. June, 1037, Hamadan, N. Persia

After studying at Bokhara, Avicenna

AVOGADRO

travelled widely, leading an active and eventful life including imprisonment and escape therefrom. He is noted for his books, especially the *Canon Medicinae* which was a standard medical text-book even up to the seventeenth-century. The compilation is not original, but is based on the work of Galen, Hippocrates and Aristotle. The first of many translations was by the twelfth-century Gerard of Cremona. He also wrote on mathematics and philosophy, and is remembered for his neoplatonic-Aristotelian philosophy known as Avicennism.

Avogadro, Amedeo, Conte di Quaregna
Italian physicist

b. Aug. 9, 1776, Turin

d. July 9, 1856, Turin

In 1806 Avogadro taught physics in Turin becoming professor of mathematical physics there (1834-50). He is famous for his discovery (1811) of the law named after him, which states that at the same temperature and pressure equal volumes of all perfect gases comprise the same number

of molecules. This important discovery was completely ignored by his contemporaries and it was many years before its truth was recognised, despite the fact that Ampère suggested a similar theory in 1814. (See Cannizzaro.)

Ayrton, William Edward
English physicist

b. Sept. 14, 1847, London

d. Nov. 8, 1908, London

Educated at University College, London, Ayrton became a professor of natural philosophy and telegraphy in the Imperial College of Engineering at Tokio. In 1879 he returned to be professor of applied physics at South Kensington. With Perry he invented an ammeter and voltmeter among a host of other electrical inventions too numerous to mention, and he published *Practical Electricity* (1887). His first wife, Matilda Chaplin, graduated at Surgeons' Hall, Edinburgh, as one of the pioneer women doctors; and his second wife, Hertha Marles, was a scientist who studied the electric arc (with her husband).

B

Babbage, Charles

English mathematician

b. Dec. 26, 1792, Teignmouth, Devon

d. Oct. 18, 1871, London

Educated at Cambridge, Babbage became an F.R.S. in 1816 and did much work on the calculus of functions. Inaccuracies of mathematical tables led him to attempt the construction of a calculating machine, which he never completed, and he spent many of his later years on similar projects. He was at one time professor of mathematics at Cambridge and did much towards the foundation of the Astronomical and the Statistical Societies.

Babcock, Harold Delos

American physicist

b. Jan. 24, 1882, Edgerton, Wis.

Educated at California University, Babcock became a specialist in spectroscopy at the Mt. Wilson Observatory (1909). His measurement of the magnetic field of the star 78 Virginis provided the first link between the electro-magnetic and the relativity theories.

Babinet, Jacques

French physicist

b. 1794

d. 1872

Babinet was the first to suggest that some particular ray of light should be chosen and its wavelength used as a standard of length. The red cadmium line was decided on eventually and the angstrom was redefined as a fraction of this.

Babo, Clemens Heinrich Lambert von

German chemist

b. 1818

d. 1899

In 1847 Babo discovered that the vapour pressure of a liquid is lowered by solution and that the relative fall is proportional to the concentration.

Bacon, Francis, Baron Verulam, Viscount St. Albans

English philosopher and statesman

b. Jan. 22, 1561, London

d. Apr. 9, 1626, Highgate, London

Educated at Cambridge, Francis Bacon is famous as a philosopher and a statesman though his record as the latter did him little credit. Trained as a lawyer he became Lord Chancellor after a long career of intrigue, ingratitude to friends and servility to those in power. He was eventually disgraced on charges of bribery and corruption. In science, however, he revealed a brilliant philosophical brain, and his insistence on the experimental method of determining truth did much to inaugurate modern scientific method. His *Advancement of Learning* (1605) in its fuller version *De Augmentis Scientiarum* (1623), and the *Novum Organum* (1620) were the first two volumes of his great



FRANCIS BACON

BACON

unrealised *Instauratio Magna*, an assessment of all knowledge. Bacon's dismissal of the deductive logic which the schools accepted from Aristotle, his continued advocacy of inductive method, of the accumulation of fact and observation, his determination that truth should not be the child of authority, that knowledge is acquired and must be sifted, systematised and applied, ushered in the modern scientific era. Though he speaks of heat as motion and light as a thing of finite speed, the resounding discoveries of his contemporaries went unrecognised, and Copernicus, Galileo, Kepler, Harvey, Napier find no place in his pages. Among minor works he wrote a treatise on the tides. His keen appreciation of the value of experiment led to his death. Whilst on a coach journey in winter he alighted, bought a fowl and stuffed it with snow to see if cold would delay putrefaction. In doing so he caught a chill and died from bronchitis.

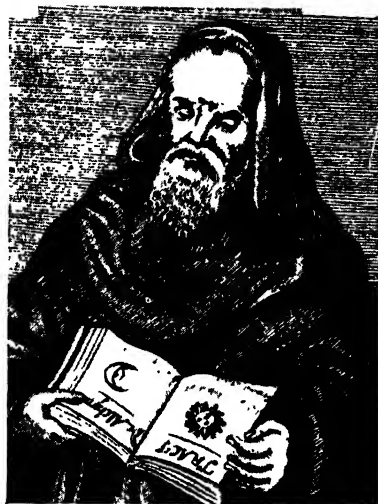
Bacon, Roger

English scientist

b. c. 1214, Ilchester, Somerset

d. 1294, Oxford

A monk of the Franciscan Order and one of the most profound and original thinkers of his time, the Doctor Mirabilis was unfortunate enough to be imprisoned for considerable periods either because of his criticisms of his superiors or because of the suspicion, engendered by his extraordinary knowledge, that he dabbled in magic. His fifteen years of confinement ended about two years before his death. Bacon made considerable advances in optics, stating the laws of reflection, and in a general way, of refraction, and giving a rough explanation of the rainbow and, more important, of magnifying glasses. He also was an excellent chemist and was the first to emphasise that medicine should make use of remedies provided by chemistry. His works record the composition of gunpowder (1248), but he was not necessarily the discoverer. A sound knowledge of geography and astronomy enabled him to suggest methods for the correction of the calendar, which he



ROGER BACON, Doctor Mirabilis. The Sun and Moon (Sol and Luna or the King and Queen) were the alchemists' symbols for gold and silver.

discovered to be inaccurate. He suggested a lighter-than-air machine on the lines of creating a vacuum in a globe, and constructed an automaton in the form of a brazen head. He emphasised the importance of mathematical investigations, and wrote an elegant Latin; the legacy of his times lingers in his belief in the philosopher's stone and astrology.

Baekeland, Leo Hendrik

American chemist

b. 1863, Ghent

d. Feb. 23, 1944, Beacon, N.Y.

A Belgian by birth, Baekeland became professor of chemical engineering at Columbia University. He was the inventor of a type of photographic paper (Velox), but is even better known as the inventor of 'Bakelite'.

Baer, Karl Ernst von

German biologist

b. Feb. 29, 1792, Piep, Estonia

d. Nov. 28, 1876, Dorpat

After studying at Dorpat and later at Würzburg, Baer gained a professorship at

Königsberg and then moved in 1834 to St. Petersburg. He is famous for his far-reaching discovery of the mammalian ovum within the Graafian follicle and of the *chorda dorsalis* or notochord. In his work on embryology he formulated the general law that animals resemble each other more and more the farther back in embryonic development we trace them. He came to this conclusion as a result of having inadvertently mixed up some specimen embryos and of finding himself unable to say afterwards which was which. In 1835 he published *Development of Fishes* and later a monograph on the fishes of the Baltic and Caspian seas.

• **Baeyer, Johann Friedrich Wilhelm Adolf von**

German organic chemist

b. Oct. 31, 1835, Berlin

d. Sept. 5, 1917, Munich

After studying under Bunsen at Heidelberg and under Kekulé, Baeyer taught in Berlin and from there went to Strasbourg and then to Munich as professor (1875). He is best known for his researches on indigo for which he was awarded the Davy medal in 1881; he produced it synthetically in 1870, and worked also on its derivatives. He suggested the photosynthesis of formaldehyde by plants and in 1885 evolved a strain theory of carbon rings to account for the instability of the many compounds of acetylene (discovered in 1836 by Edmund Davy) which he was able to prepare. He was awarded the Nobel prize for chemistry in 1905 for his work in synthetic chemistry, notably on indigo and uric acid compounds.

Baily, Francis

English astronomer

b. Apr. 28, 1774, Newbury, Berks

d. Aug. 30, 1844, London

After a life of adventure and business, Baily took up astronomy on his retirement from affairs in 1825, and was President of the Royal Astronomical Society when he died. He was the first observer of Baily's beads, a phenomenon attending eclipses of the sun. He calculated the mean density of the earth by Cavendish's method, arriving at a value of 5.66.

Baird, John Logie

Scottish inventor

b. 1888, Helensburgh

d. June 14, 1946

After studying electrical engineering at the Royal Technical College, Glasgow, Baird entered upon a business career, in the manufacture of boot-polish and jam. Ill health caused him to turn to the study of television, and he invented and demonstrated (1926) the first practical system. The following year he succeeded in transmitting images of faces from London to Glasgow, and in 1928 from London to New York. His system was for a time in use in Germany and Britain (from 1929). Further experiment on the development of television yielded a method of producing three-dimensional and coloured images (1944), and realised the possibility of projecting images on to a cinema screen. His method of television by infra-red rays led to the development of modern directional devices.

Baird, Spencer Fullerton

American naturalist

b. Feb. 3, 1823, Reading, Pa.

d. Aug. 19, 1887, Woods Hole, Mass.

Educated at Dickinson College, Carlisle, Pa., Baird became professor of natural history there and made a vast collection of North American fauna. One-time secretary of the Smithsonian Institution, Washington, he was an authority on the birds of N. America, producing several books on the subject, including (with Brewer and Ridgway) *A History of North American Birds*. He was also chief government commissioner of fish and fisheries.

Baker, Herbert Brereton

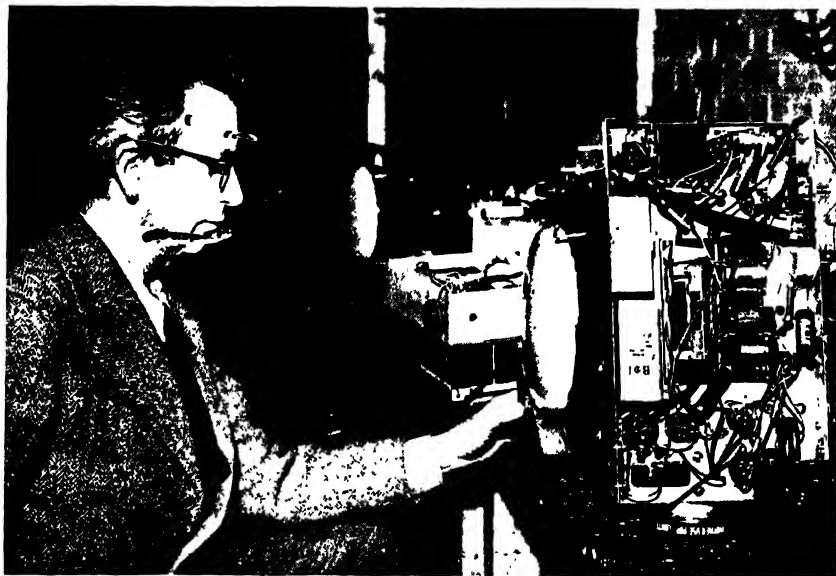
English chemist

b. June 25, 1862, Livesey, nr. Blackburn

d. Apr. 27, 1935

Baker was educated at Oxford and became professor at the Imperial College of Science (1912-32). Following Dixon, he carried on research on the influence of water on chemical change. He also investigated nitrogen trioxide in 1907 and the atomic weight of tellurium in the same year. He was an authority on desiccating gases and, in the first world war, on poison gases.

BALARD



JOHN LOGIE BAIRD conducts a television experiment at home.

Balard, Antoine Jérôme

French chemist

b. Sept. 30, 1802, Montpellier, Hérault

d. Apr. 30, 1876, Paris

Educated at Montpellier, Balard became demonstrator there and in 1826 discovered in sea-water the element which he named *bromine*. He also discovered hypochlorous acid, and in 1834, chlorine monoxide. He became professor of chemistry at the Sorbonne, and at the Collège de France.

Baldwin, James Mark

American philosopher and psychologist

b. Jan. 12, 1861, Columbia, S.C.

d. Nov. 8, 1934, Paris

After being professor of psychology at Princeton where he was educated, Baldwin became professor of philosophy and psychology at the Johns Hopkins University, Baltimore (1903-09), and in the National University of Mexico (1909-13). He was the first to develop in detail the idea that individual modifications though not inherited might cooperate with inherited mutations to help the course of

evolution. Among many works of his is a *History of Psychology* (1913); and he was co-founder and editor of *Psychological Review*. He was an expert on child psychology, and founded psychological laboratories at Toronto (the first in the Dominions) and Princeton Universities.

Balfour, Sir Andrew, Bart.

Scottish physician

b. Jan. 18, 1630, Denmiln, Fifeshire

d. Jan. 10, 1694, Edinburgh

Educated at St. Andrews and London, Balfour eventually settled at Edinburgh. With Sir Robert Sibbald he was responsible for the founding of the Royal Botanic Garden, Edinburgh, and was first president of the Royal College of Physicians of Edinburgh. He also started the hospital which is now the Edinburgh Royal Infirmary.

Balfour, Francis Maitland

English biologist

b. Nov. 10, 1851, Edinburgh

d. July 19, 1882, Switzerland

The brother of the Prime Minister, A. J. Balfour, Francis Balfour was a brilliant worker at Cambridge, to which he came from Harrow. He was elected F.R.S. in 1878 and became professor of animal morphology at Cambridge in 1882. Before his early death through a fall on the Aiguille Blanche de Peuterey, he completed in 1880 his famous *Comparative Embryology* which is recognised as the foundation of the modern study of that subject.

Balfour, John Hutton
Scottish botanist

b. Sept. 15, 1808, Edinburgh

d. Feb. 11, 1884, Edinburgh

A relative of James Hutton (geologist), Balfour was educated at Edinburgh and became professor of botany at Glasgow, and then returned to a similar post at Edinburgh. He was noted as a writer of text-books on botany.

Ball, Sir Robert Stawell
Irish astronomer

b. July 1, 1840, Dublin

d. Nov. 25, 1913, Cambridge

Educated at Chester and Trinity College, Dublin, Ball held various astronomical posts including that of Astronomer Royal for Ireland (1874). He was elected F.R.S. and in 1892 became Lowndean professor of astronomy at Cambridge. He wrote many popular books on astronomy and his original mathematical research on screw motions is embodied in his *Theory of Screws* (1876).

Balmer, Johann Jakob
Swiss physicist

b. May 1, 1825, Lausen

d. Mar. 12, 1898, Basle

Educated at Basle, Balmer was a university lecturer from 1865 to 1890. In 1885 he discovered a formula to embrace the frequencies of the hydrogen lines in the visible spectrum. Other workers who followed in this field of research were Rydberg and Paschen. Balmer's formula is $\nu = R(1/2^2 - 1/m^2)$, $m=3, 4, \dots$, where ν is the frequency and R the Rydberg constant ($R_H = 109677.6 \text{ cm}^{-1}$).

Baly, Edward Charles Cyril
English chemist

b. Feb. 9, 1871

d. Jan. 3, 1948

Educated at University College, London, Baly became assistant professor of chemistry there before becoming professor of inorganic chemistry at Liverpool. He was elected F.R.S. in 1909. He showed by experiment that ~~under the~~ influence of light, small quantities of sugars and other organic substances are generated from a mixture of such simple substances as water, carbon dioxide and ammonia.

Banks, Sir Joseph, Bart.
English naturalist

b. Feb. 13, 1743, London

d. June 19, 1820, Isleworth, Middlesex

Educated at Harrow, Eton and Oxford, Banks was financially secure and so able to indulge his scientific tastes. He did so by embarking on many expeditions. The most famous of these was that with Captain Cook in the 'Endeavour', from which he returned with a considerable number of new specimens. He became president of the Royal Society in 1778, having been a fellow since 1766. See J. H. Maiden, *Sir Joseph Banks* (1909).

Banting, Sir Frederick Grant
Canadian physician

b. Nov. 14, 1891, Alliston, Ontario

d. Feb. 21, 1941, Newfoundland

Trained at Toronto, Banting became professor of medical research there in 1923, and with Macleod he gained the Nobel prize for medicine in the same year. He is remembered for his discovery in 1922, with Best and Macleod, of insulin, which has proved so useful in the treatment of diabetes. He was killed in an air-crash.

Bárány, Robert

Austrian physician

b. Apr. 22, 1876, Vienna

d. Apr. 8, 1936, Uppsala

Educated in Vienna, Bárány became an authority on diseases of the ear and throat and was awarded the Nobel prize for medicine in 1914 for his new methods of diagnosis. In 1917 he went to Uppsala,

BARBARO

becoming professor there, and he did important work on the cerebellum.

Barbaro, Ermolao

Italian scholar

b. 1454

d. 1493 (?)

One of the earliest writers on natural history, Barbaro did invaluable work on the correction of previous books, in particular Pliny's *Natural History* and some of Aristotle's works.

Barcroft, Sir Joseph

Irish physiologist

b. July 26, 1872

d. Mar. 21, 1947

Educated at Cambridge, and a lecturer at the Royal College of Physicians, Barcroft rose to be professor of physiology at Cambridge, and in 1941 became the director of animal physiology (Agricultural Research Council). He was elected F.R.S. in 1910 and was awarded the Copley medal in 1944. His reputation rests upon his original researches in physiology, e.g., the respiratory function of the blood, the brain and its environment, among other topics. In this connection he did not spare himself, and conducted experiments on himself to determine the effects of intense cold and reduced pressure on the human body.

Barger, George

British chemist

b. 1878, Manchester

d. Jan. 5, 1939

Son of a Dutch father and English mother, and educated in Holland, London and Cambridge, Barger proceeded, after a post in London, to a professorship in Edinburgh and then Glasgow. He was elected F.R.S. in 1919 and with Harington was responsible for the synthesis of thyroxine. (See also Kendall.)

Barkla, Charles Glover

English physicist

b. June 7, 1877, Widnes, Lancs.

d. Oct. 23, 1944, Edinburgh

Trained at Liverpool and Cambridge, Barkla became professor of physics in

London and then professor of natural philosophy at Edinburgh (1913). Elected F.R.S. in 1912, he gained the Nobel prize for physics in 1917, and is noted for his researches on X-rays and other short wave emissions. He demonstrated that secondary emission is of two kinds—scattered X-rays and a characteristic fluorescent radiation, and that the first is polarised.

Barnard, Edward Emerson

American astronomer

b. Dec. 16, 1857, Nashville, Tenn.

d. 1923, Chicago

Born in poor circumstances, Barnard was apprenticed to a photographer at the age of eight, but he gained a post in the Vanderbilt University observatory in 1883 after discovering his first comet in 1881. He went to the Lick Observatory in 1887 and in 1892 discovered the fifth satellite of Jupiter. In 1895 he went to the Yerkes Observatory where he discovered the so-called 'dark' nebulae, and catalogued 182 of them. He was a great planetary observer, and contributed much to celestial photography.

Barnard, Joseph Edwin

English physicist

b. 1870, London

Noted for his work in microscopy, Barnard devised in 1925 a method of photographing with ultra-violet light organisms too small to be seen visually in any microscope, since the length of the visual rays was greater than the size of the object to be detected. The result was a triumph of patience and experimental skill. At the National Institute for Medical Research at Hampstead, with Dr. Gye, he demonstrated the existence of what was believed to be a cancer virus. He was elected F.R.S. in 1924.

Barrett, Sir William Fletcher

British physicist

b. Feb. 10, 1844, Jamaica

d. May 26, 1925

Educated privately, Barrett became assistant to Tyndall and eventually professor of physics at Dublin (1873-1910). He is noted for his psychical research and was

one of the first to perform experiments on thought transference (telepathy). He also did much valuable work on magnetic alloys, in particular on Stalloy, a silicon iron alloy.

Bartholinus, Erasmus

Danish philosopher

b. 1625, Roskilds

d. 1698, Copenhagen

A professor of mathematics and medicine at Copenhagen, Bartholinus discovered the double refraction of calcite in 1669.

Bartholinus, Thomas

Danish anatomist

b. 1616, Copenhagen

d. 1680, Hagestaed

The brother of Erasmus and a pupil of Severino, Bartholinus became professor of mathematics and anatomy at Copenhagen, and is remembered as the discoverer in 1653 of the lymphatic glands, which discharge into the thoracic duct and so into the blood stream. His son, Casper, gave his name to a vaginal gland and a sublingual duct.

Bartholomaeus Anglicus (de Glanvilla)

English Franciscan monk

13th century

Educated at Oxford, Bartholomaeus went to Paris (c. 1220) as a lector and then to Magdeburg. In 1250 he wrote a famous encyclopaedia, *De Proprietatibus Rerum*, of which the scientific side is of particular interest, dealing as it does with all the known branches of medical science, astronomy and geography.

Bartlett, Sir Frederic Charles

English psychologist

b. Oct. 20, 1886, Stow-on-the-Wold, Glos.

Educated at Cambridge and London, Bartlett became reader in experimental psychology at Cambridge in 1922 and professor in 1931. He was elected F.R.S. in 1932, and is the author of many books on psychology and its application to everyday life, e.g., *Problem of Noise* (1934). He took a prominent part in the testing of servicemen during the last war, devising many ingenious machines for the purpose.

Bary, Heinrich Anton de

German botanist

b. Jan. 26, 1831, Frankfort-on-Main

d. Jan. 17, 1888, Strasbourg

Bary was the first to show that in certain kinds of lichen the fungus cannot live apart from its particular alga, a partnership of two living things known as symbiosis.

Bassi, Agostino

Italian scientist

b. 1773, Lodi, Milan

d. 1856

An amateur microscopist, Bassi was the first to prove that a vegetable micro-organism could be a cause of infection. He experimented with silkworms.

Bates, Henry Walter

English naturalist

b. Feb. 8, 1825, Leicester

d. Feb. 10, 1892

A self-taught naturalist, Bates accompanied Wallace to South America in 1847 on an expedition and remained eleven years. He was the discoverer of Batesian mimicry, that is, the surface resemblance of one species to another for purposes of self-protection. His observations were made on butterflies and moths. He published *A Naturalist on the Amazon* (1863), still one of the classics of English natural history.

Bateson, William

English biologist

b. Aug. 8, 1861, Whitby, Yorks.

d. Feb. 8, 1926, Merton, Surrey

Educated at Rugby and Cambridge, Bateson became professor of biology at the latter place in 1908, and in 1912 was professor of physiology at the Royal Institution. He became president of the British Association in 1914. He was an enthusiastic disciple of Abbé Mendel, the value of whose work had not previously been recognised. Bateson did for Mendel what Huxley did for Darwin. Though accepting the fact of evolution, however, he doubted the fact of progressive variation in species. Many of his criticisms have been finally dealt with by later research.

Bauer, Georg. See **Agricola, Georgius**

BAUMÉ

Baumé, Antoine

French chemist

b. 1728, Senlis, Oise

d. Oct. 15, 1804, Paris

A pharmaceutical chemist in Paris, Baumé rose to be professor of chemistry at the Collège de Pharmacie. He was the inventor of the hydrometer named after him and invented many technical processes and improvements in the dyeing industry.

Baxter, Gregory Paul

American chemist

b. Mar. 3, 1876, Somerville, Mass.

Educated at Harvard, Baxter became professor of chemistry there in 1915 and was associated with Bliss in 1930 and with Alter in 1935 in the determination of the atomic weight of lead, the end-product, in radioactive minerals. This calculation affords grounds for an estimation of the age of the minerals.

Bayliss, Sir William Maddock

English physiologist

b. May 2, 1860, Wolverhampton

d. Aug. 27, 1924, Hampstead, London

Trained as a medical student at University College, London, Bayliss specialised in physiology, upon which he did thirty-five years' research. His most important work was connected with electromotive phenomena of the heart's action and the nervous mechanism of the viscera. With Starling he discovered *secretin*, the hormone which is responsible for the secretions of the pancreas. Bayliss wrote a well-known textbook, the *Principles of General Physiology* in 1914. He was elected F.R.S. in 1903, and was awarded the Copley medal in 1919.

Beaumont, William

American physiologist

b. Nov. 21, 1785

d. 1853

After studying privately, Beaumont became a surgeon in the U.S. army. His researches on the chemical nature of digestion and his work on the gastric juice (1833) were of the highest importance. He was much helped by having a Canadian patient who

lived for years with a two-inch hole in his stomach from a gunshot wound.

Becher, Johann Joachim

German chemist and economist

b. 1635, Spire

d. Oct., 1682, London

Becher, whose study of minerals, *Physica Subterranea* (1669) was the first attempt to unify physics and chemistry, shares with Stahl the dubious honour of launching the phlogiston theory of combustion on its persistent career. In his economic activities he advocated the colonisation of South America and the mercantile system; and he founded the Austrian College of Commerce. He carried on experiments for obtaining gold from sand from the Danube by transmutation.

Beckmann, Ernst

German chemist

b. July 4, 1853, Solingen

d. July 12, 1923, Berlin

Chiefly concerned with organic chemistry, Beckmann became professor of chemistry at Erlangen and Leipzig. He discovered in 1886 the arrangement of oximes of ketones into acid amides or anilides, named the *Beckmann molecular transformation*, and was the inventor of two standard pieces of apparatus used for the determination of the freezing and boiling points of solutions. The sensitive Beckmann thermometer is of use in determining molecular weights in solutions by cryoscopy.

Becquerel, Antoine César

French physicist

b. Mar. 8, 1788, Châtillon-sur-Loing

d. Jan. 18, 1878, Paris

Educated at Paris, Becquerel served for a time in the army, and is noted as one of the creators of electro-chemistry. In 1837 he was awarded the Copley medal of the Royal Society, and in the same year became professor of physics at the Muséum d'Histoire Naturelle. In 1836 he was the first to use electrolysis as a means of recovering metals from ores, when he obtained copper from sulphide ores. His son, Alexandre Edmond (see below), was associated with him in much of his work.

Becquerel, Alexandre Edmond

French physicist

b. Mar. 24, 1820, Paris

d. May 11, 1891, Paris

The son and pupil of Antoine César (see above), Becquerel eventually replaced his father at the Muséum d'Histoire Naturelle. He made a special study of photo-chemical effects of solar radiation, and the phosphorescence of sulphides and uranium compounds. In this connection he constructed a phosphoroscope. He also did research on diamagnetism and paramagnetism.

Becquerel, Antoine Henri

French physicist

b. Dec. 15, 1852, Paris

d. Aug. 25, 1908, Croisic, Brittany

The son of Alexandre Edmond (see above), he was educated at Paris and became professor at the École Polytechnique; he was a Nobel prize winner for physics in 1903 with the Curies. In 1896 he discovered the rays named after him, which are given out by uranium salts. He invented a phosphoroscope to study phosphorescence, and worked on magnetism and the polarisation of light.

Beebe, Charles William

American naturalist

b. July 29, 1877, Brooklyn, N.Y.

Educated at Columbia, Beebe became curator of ornithology and later director of scientific research at the New York Zoological Society, and earned fame as an explorer and collector. He led many scientific expeditions and was one of the first to attempt really deep sea exploration (Aug., 1934) in a specially constructed diving bell which he made himself. He reached a depth of 1,000 metres. Among many well-known books of his are *Pheasants, Their Lives and Homes* (1926) which won for him the Elliott medal, and *Half Mile Down* (1934).

Behring, Emil Adolph von

German bacteriologist

b. May 15, 1854, Hensdorf, E. Prussia

d. May 31, 1917, Marburg

A surgeon in the Prussian army, Behring eventually became professor at Halle and

then at Marburg. In 1890, in work with Kitasato, he made the important discovery that immunity against tetanus and diphtheria (see Roux) could be produced by injecting serum from an animal which had recovered from the disease. He introduced the term *antitoxin*. The first Nobel prize for medicine was awarded to him in 1901.

Beilby, Sir George Thomas

Scottish chemist

b. Nov. 17, 1850, Edinburgh

d. Aug. 1, 1924, Hampstead, London

Educated at Edinburgh, Beilby became an industrial chemist and invented a new process for retorting oil shale. He also made important advances in the synthesis of alkaline cyanides and erected at Leith the first factory for this purpose. Elected F.R.S. in 1906 he was the founder of the Fuel Research station at East Greenwich.

Beilstein, Friedrich Konrad

German chemist

b. 1836

d. 1906

Professor of the Institute of Technology, St. Petersburg (1866), Beilstein is remembered as the author of the famous *Handbuch der Organischen Chemie* (1880). This, in its revised and augmented form, remains the standard reference book on organic chemistry.

Bekhterev, Vladimir Mikhailovich

Russian neuropathologist

b. 1857, Viatka Province

d. Dec. 24, 1927, Moscow

After study at St. Petersburg, Bekhterev did research in European universities before becoming professor at Kazan. He was famous for his work on nerve currents and founded the psycho-neurological institute in Leningrad. He wrote several works on the nervous system and disease, including *Functions of the Nervous Centres* (1909) and *Nervous System Diseases* (1911).

Bell, Alexander Graham

Scottish-American inventor

b. Mar. 3, 1847, Edinburgh

d. Aug. 2, 1922, Baddeck, Nova Scotia

The son of a Scottish teacher of speech

BELL

and elocution, and educated at Edinburgh, London and in Germany, Graham Bell went to Canada and the U.S.A. in 1871 and became professor of vocal physiology at Boston. He taught his father's system of visible speech for deaf-mutes, and invented the telephone, exhibited in 1876. Among other inventions of his were the photophone (1880) and the graphophone, one of the earliest gramophones (1887).

Bell, Sir Charles

Scottish anatomist and surgeon

b. Nov. 1774, Edinburgh

d. Apr. 28, 1842, Hallow Park, nr. Worcester

Educated at home, owing to financial difficulties Bell had a hard struggle in his early life. He was surgeon to the Middlesex Hospital (1814) and was present on the field of Waterloo. In 1811 he made the important discovery that the nerve filaments of sensation are separate from those of motion, and this was restated (1830) in *The Nervous System of the Human Body*. This and related discoveries were probably the most important advances in physiology since the time of Harvey. He became professor of surgery at Edinburgh in 1836.

Bell, Henry

Scottish engineer

b. 1767, Torphichen, Linlithgowshire

d. Nov. 14, 1830, Helensburgh

Trained in carpentry and engineering under Rennie, Bell is noted as the builder of one of the first steamships in Britain. This was the 25-ton 'Comet' propelled along the Clyde in 1812 by a three horse-power engine at seven miles per hour. Fulton had preceded him in America but there is little doubt that he had gained his idea from Bell during an earlier visit to England.

Belon, Pierre

French naturalist

b. 1518, Soulletière, Maine

d. Apr., 1564, Paris

After studying medicine in Paris, Belon travelled widely in south-eastern Europe and Asia Minor. He introduced the cedar

to France and wrote important books on natural history. He was murdered by thieves whilst gathering herbs late at night.

Beneden, Edouard van

Belgian cytologist

b. 1845, Liège

d. 1910

Famous for his researches on reproduction, Beneden showed that the number of chromosomes is the same for each cell in a given body, and that this number is probably a characteristic of the species. He also demonstrated that this number decreased during maturation and was restored during the sexual process. His work was published in 1887.

Bennet, Abraham

English physicist

b. 1750

d. 1799

An early experimenter in electricity, Bennet was the inventor of the gold-leaf electroscope. He made a simple influence or induction machine in 1789.

Bentham, George

English botanist

b. Sept. 22, 1800, Stoke, nr. Portsmouth

d. Sept. 10, 1884

A nephew of Jeremy Bentham, George Bentham was trained for the bar, but was able to abandon the law for botany on account of his ample financial resources. A patient and industrious collector, he is noted for his works on botany and in particular for his monumental *Genera Plantarum* in collaboration with Joseph Hooker.

Bergius, Friedrich

German chemist

b. Oct. 11, 1884, Goldschmieden, nr. Breslau

d. Mar. 31, 1949, Buenos Aires

After study at Breslau, Leipzig, Berlin and other universities, Bergius did research on the use of high pressure in chemical action, writing a book on the subject. This work led to his method for the direct conversion of coal dust into oil by the

action of hydrogen under high pressure, without intermediate products. The oil so obtained by synthesis resembles crude mineral oil. He was awarded the Nobel prize for chemistry with Karl Bosch in 1931. Another of his processes was the hydrolysis of wood to sugar and cattle feed.

Bergman, Torbern Olof

Swedish physicist and chemist

b. Mar. 20, 1735, Katrineberg, Västergötland

d. July 8, 1784, Medevi, Lake Vetter

After study under Linnaeus at Uppsala, Bergman became professor of physics there in 1767. He investigated carbon dioxide which he called *aerial acid* (Priestley's *fixed air*) and succeeded in the preparation of artificial mineral waters. He discovered also hydrogen sulphide in mineral springs. In common with other contemporary chemists he was a believer in phlogiston, the existence of which was completely disproved by Lavoisier.

Bernard, Claude

French physiologist

b. July 12, 1813, Saint-Julien, nr. Villefranche

d. Feb. 10, 1878, Paris

Beginning as a writer of plays, Bernard was persuaded to take up medicine, and after studying in Paris he eventually became professor of physiology at the Collège de France. He was a very searching thinker and experimenter. He proved that the body can build up complex chemicals as well as break them down, demonstrating, for example, the production of glycogen by the liver. He showed that digestion only starts in the stomach, and continues in the intestines. He established physiology as an exact science and his *Introduction to the Study of Experimental Medicine* (1865) remains a classic. See Sir Michael Foster, *Life of Bernard* (1899).

Bernard de Gordon

French physician

c. 1285, Gourdon

A medical practitioner of Montpellier, Bernard wrote a book in which there is the



FRIEDRICH BERGIUS

first mention of spectacles and the first description of a truss.

Bernouilli, Jacques (or Bernoulli)

Swiss mathematician

b. Dec. 27, 1654, Basle

d. Aug. 16, 1705, Basle

A professor of mathematics at Basle in 1687, Jacques Bernouilli was one of the first to make full use of the differential calculus and was the introducer of the term *integral* with an attempt to construct an integral calculus. He also made important advances in the mathematics of curves, e.g. the catenary, spiral, etc. He helped to shape probability theory by his *Ars Conjectandi* (1713) and *Bernouilli's numbers* are his.

Bernouilli, Jean (or Bernoulli)

Swiss mathematician

b. July 27, 1667, Basle

d. Jan. 1, 1748, Basle

The brother of Jacques and the father of Daniel, Jean Bernouilli became professor of mathematics at Basle in 1705 after Jacques. Noted for his discovery of the exponential calculus, he was the first to use 'g' to

BERNOULLI

denote the acceleration due to gravity. His reputation is marred by unpleasant controversies, the claiming of some of his brother's work as his own, and his expulsion of his son Daniel from his house because he had won a prize in competition with him. He introduced the famous brachistochrone problem.

Bernouilli, Daniel (or Bernoulli)
Swiss mathematician

b. Jan. 29, 1700, Basle

d. Mar. 17, 1782, Basle

The second son of Jean, Daniel Bernouilli was professor of natural philosophy at Basle in 1782, and for a time professor of mathematics at Petrograd; he later returned to Basle. He was the first to point out the usefulness of resolving a compound motion into motions of translation and rotation, wrote a treatise on the tides and another on the vibration of strings, and anticipated Bessel functions. He was the first to attempt a kinetic theory of gases. *Hydrodynamica* (1738), a theoretical and practical study of equilibrium pressure and velocities of fluids, is his most important work, and contains his exposition of *Bernouilli's equation*, an early formulation of the conservation of energy principle. He has been called the founder of mathematical physics.

Berosus

Chaldean philosopher

c. 3rd century, B.C.

A priest in the temple of Belus, Berosus is said to have invented the hollow sun-dial cut in a block of stone. A fixed bar which was arranged parallel to the earth's axis cast its shadow on the inside hemispherical surface and so marked the twelve hours of day. Berosus also wrote a history of the Babylonian Chaldeans, but only references to it are now extant.

Berthelot, Marcellin Pierre Eugène

French chemist

b. Oct. 29, 1827, Paris

d. Mar. 18, 1907, Paris

The first professor of organic chemistry at the Collège de France (1865), Berthelot was put in charge of the scientific defence of Paris in 1870 owing to his expert know-

ledge of explosives, and was minister for foreign affairs, 1895-96. He was an authority on, and indeed in great measure the founder of, thermo-chemistry, and with Thomsen, stated that every spontaneous chemical action is accompanied by the evolution of heat—a statement now known to be only generally true. About 1844 he attempted to liquefy oxygen with a pressure of 800 atmospheres, but did not succeed because there was no reduction in temperature. He constructed a standard piece of apparatus for the determination of the latent heat of steam, and also discovered dyes extracted from coal-tar. He showed that atmospheric nitrogen can be fixed by electric discharges, and by bacteria in clay-soils. His investigation of glycerine in 1854 was masterly, and his syntheses of alcohol and formic acid in 1854, methane in 1856, methyl alcohol in 1857, camphor in 1859, and acetylene in 1862 put an end to the distinction which had previously been made between organic and inorganic compounds.

Berthollet, Claude Louis, Comte

French chemist

b. Dec. 9, 1748, Talloire, nr. Annecy, Savoie

d. Nov. 6, 1822, Arcueil, Paris

After studying medicine at Turin, Berthollet became connected with Lavoisier (q.v.) and eventually was professor at the Academy of Sciences in Paris. He was scientific adviser to Napoleon during the Egyptian campaign of 1798. He is noted for his analysis of ammonia in 1785, and his researches on chlorine and its compounds during which he discovered the bleaching action of chlorine, and the composition of prussic acid. With regard to the latter he was able to show that acids need not contain oxygen as had been assumed by Lavoisier. His most famous work was his *Essai de statique chimique* (1803).

Berzelius, Jöns Jakob, Baron

Swedish chemist

b. Aug. 20, (29 ?), 1779, Väfversunda, Sörgård, nr. Linköping

d. Aug. 7, 1848, Stockholm

A medical graduate of Uppsala, Berzelius became professor of pharmacy and medicine at Stockholm, and later professor of chemistry at the new Medical Institute there. He discovered ceria, the oxide of cerium, in 1803, selenium in 1817, thorium in 1828 and also silicon, and was the first to obtain calcium, barium and strontium, tantalum and zirconium as elements. He investigated the compounds of fluoric acid, introduced the name *halogen* in 1825, and produced a new system of classification and nomenclature of chemical compounds. He was also responsible for the idea of representing elements by their initial letter or letters. The term *allotropy* was used by him to indicate the existence of substances in different forms, e.g., carbon as charcoal and diamond, and he also referred to *catalytic action* and *isomerism*. He produced an electrochemical theory which exerted a profound influence on the development of chemistry, and (1808-18, 5th ed. 1843-48) a *Lehrbuch der Chemie*. He demonstrated the application of Dalton's atomic theory to both organic and inorganic substances, and composed the first accurate table of atomic weights.

Bessel, Friedrich Wilhelm

German astronomer and mathematician

b. July 22, 1784, Minden

d. Mar. 17, 1846, Königsberg

Starting as a ship's clerk, Bessel became director of the Königsberg Observatory in 1810 through his work on the comet of 1807. He did outstanding work on star catalogues and in 1840 he called attention to the probability of another planet beyond Uranus—a forecast which led to the discovery of Neptune. In 1838 he determined the parallax of the star 61 Cygni, the first reliable measurement of a star's distance, and he was the first to suggest the existence of dark stars (in particular, companions of Sirius and Procyon), which was long afterwards proved correct. His work in astronomy introduced a new era in precision. In pure mathematics he systematised the important Bessel functions. See H. Durège, *Bessels' Leben und Wirken* (1861), and G. N. Watson, *A Treatise in the Theory of Bessel Functions* (1922).

Bessemer, Sir Henry

English engineer

b. Jan. 19, 1813, Charlton, Herts.

d. Mar. 15, 1898, Denmark Hill, London

A Fellow of the Royal Society in 1879, Bessemer is noted for his invention of a process for the manufacture of steel which led to a great reduction in costs. He decarbonised cast iron by forcing air through it whilst molten.

Best, Charles Herbert

Canadian physiologist

b. Feb. 27, 1899, West Pembroke, Me.

Educated at Toronto and London, Best became professor of physiology at Toronto in 1929. He was associated in 1922 with Banting and Macleod in the discovery of insulin, which is used in the treatment of diabetes.

Bevan, Edward John

English chemist

b. 1856, Birkenhead

d. 1921

Educated at Manchester, Bevan became associated with Cross and invented the modern method of producing artificial silk by converting cellulose into viscose (in sheet form, Cellophane), and then squirting fine jets of it into a liquid mainly consisting of sulphuric acid. He became public analyst to the Middlesex County Council.

Bhabha, Homi Jehangir

Indian physicist

b. Oct. 30, 1909

Educated at Bombay and Cambridge, Bhabha became professor of theoretical physics at Bombay in 1945, having been elected F.R.S. in 1941. He has done much original research on cosmic rays and the quantum theory. With Heitler he introduced the Cascade Theory (cosmic rays) at the same time as Carlson and Oppenheimer. See Jánossy, *Cosmic Rays and Nuclear Physics* (1948).

Bichat, Marie François Xavier

French physiologist

b. Nov. 14, 1771, Thoirrette, Jura

d. July 22, 1802, Lyons

BIELA

After studying at Lyons and Paris, Bichat was the first investigator to use the term tissue (*tissu*) as he recognised texture in various parts of the body. Mistaken in many of his conclusions through hasty work without microscopic aid, he died before being able to develop his study, which eventually became known as histology (Owen, 1844). His early death was the result of a fall from a staircase. He distinguished 21 tissues; and taught that 'life is the sum of the forces that restrict death.'

Biela, Wilhelm von
Austrian soldier

b. 1782.
d. 1856

Biela was an Austrian officer who in 1826 discovered the comet named after him. This extraordinary object after four returns at six-yearly intervals, being split into two parts on the last two occasions, failed to reappear. Its path, however, was occupied by an immense flight of meteorites which were probably its dismembered fragments.

Biffen, Sir Rowland
English botanist
b. 1874; d. July 14, 1949

After leaving Cambridge in 1896, Biffen went to Brazil to study rubber-yielding latexes. By 1900 he had begun his experiments on hybridising wheat; in 1908 he became first professor of agricultural botany at Cambridge. He was elected F.R.S. in 1914, awarded the Darwin medal in 1920, and knighted in 1925. He was a pioneer in the breeding of rust-resistant strains of wheat and his 'Little Joss' and 'Yeoman' varieties are important achievements in this field.

Bigelow, Henry Jacob
American surgeon
b. 1818
d. 1890

Son of a well-known American botanist and physician, and professor at Harvard (1849-82), Bigelow perfected the technique of lithotripsy (crushing stones in the bladder), and was an authority on orthopaedic surgery and surgery of the hip.

Binet, Alfred
French psychologist
b. July 8, 1857, Nice
d. Oct. 18, 1911, Paris

Educated in Paris, Binet studied natural science. He was the director of physiological psychology at the Sorbonne and with Simon devised a well-known method of measuring intelligence by comparison with a standard which they evolved. He wrote several books on experimental psychology, and also studied hypnotism. See R. Martin, *Alfred Binet* (1925).

Bingham, Eugene Cook
American chemist

b. Dec. 8, 1878, W. Cornwall, Vermont
Educated at the Johns Hopkins University, and at Leipzig, Berlin and Cambridge, Bingham served in the U.S. Bureau of Standards and later became professor of chemistry in Easton, Pa. He has done much original work on plastic flow and viscosity, and published *Fluidity and Plasticity* (1921).

Biot, Jean Baptiste
French mathematician and physicist
b. Apr. 21, 1774, Paris
d. Feb. 3, 1862, Paris

Biot was professor of physics at the Collège de France in 1800, and of astronomy at the University of Paris in 1809. Especially celebrated as the discoverer of the circular polarisation of light, he invented a polariscope to show polarisation by reflection. He (and Brewster) discovered biaxial crystals, i.e., crystals with two optic axes, and he was associated with Savart in the discovery of the law named after them, concerning the force in the magnetic field round a long straight current. With Gay-Lussac in 1804 he made an ascent in a balloon to study the atmosphere and the behaviour of a magnetic compass at high altitudes.

Birkeland, Kristian
Norwegian physicist
b. Dec. 13, 1867, Christiania (Oslo)
d. June 18, 1917, Tokio
Professor of physics at Christiania, Birkeland constructed a magnetised model of the earth in a vacuum tube. This he

exposed to cathode rays and obtained luminous electrical effects round the poles suggesting the cause of the aurora borealis. With Eyde he was the first (in 1903) to solve the problem of the fixation of nitrogen on an industrial scale, but a better method has since been discovered.

Black, Joseph

Scottish chemist

b. 1728, Bordeaux

d. Dec. 6, 1799, Edinburgh

Educated at Glasgow University, Black became professor of medicine there, and in 1766 of chemistry at Edinburgh, where he was a very popular lecturer. In 1754 he re-discovered carbon dioxide, the first gas to be discovered other than air. He was famous for his theory of latent heat, in which connection he invented an ice calorimeter, and also for his researches on alkalis. His famous M.D. thesis (1754), *Experiments upon Magnesia Alba, Quicklime and some other Alkaline Substances* is a classic. In 1781 he suggested to his pupils that a thin bladder filled with inflammable gas (hydrogen) would rise in the air, but there is no proof that he ever performed the experiment.

Blackett, Patrick Maynard Stuart

English physicist

b. Nov. 18, 1897

Educated at Dartmouth Naval College and Cambridge, Blackett became professor of physics at Manchester in 1937. He had been elected F.R.S. in 1933. Developing C. T. R. Wilson's cloud chamber technique he was, in 1925, the first to succeed in taking photographs of nuclear collisions involving transmutation, when he photographed an alpha particle splitting a nitrogen nucleus into an oxygen isotope nucleus and a high energy proton. In 1932, independently of Anderson, he discovered the positron. He was the first to observe nuclear disintegration by cosmic rays. He was awarded the Nobel prize for physics in 1948 for his work on atomic physics.

Blakeslee, Albert Francis

American botanist

b. Nov. 9, 1874, Genesee, N.Y.



JOSEPH BLACK

Educated at Wesleyan and Harvard, Blakeslee taught at the latter before going to Radcliffe and Connecticut Agricultural College (1907-15). In 1936 he became director of the Carnegie Station for Experimental Evolution. He is noted for his experiments (with East and Clausen) on photoperiodicity, the response of a plant to the relative length of day and night. In 1937 he made the important discovery that colchicine could be used to produce polyploidy in plants.

Blanchard, Arthur Alphonzo

American chemist

b. May 4, 1876, Boston, Mass.

Educated at the Massachusetts Institute of Technology and at Leipzig, Blanchard became professor of chemistry at the former. He has published much work, on the metal carbonyls in particular, and on other inorganic subjects.

Blane, Sir Gilbert

Scottish physician

b. Aug. 29, 1749, Blanford, Ayrshire

d. June 26, 1834, London

Educated at Edinburgh, Blane became physician to Lord Rodney and so became

BLUMENBACH

connected with the fleet. On retirement from active service he joined the staff of St. Thomas's Hospital. He was the first to insist on the use of lime-juice as a preventative for scurvy and did much to improve the health of the sailors. (See Lind, James).

Blumenbach, Johann Friedrich
German physiologist and anthropologist
b. May 11, 1752, Gotha, Thuringia
d. Jan. 22, 1840, Göttingen

The founder of anthropology, Blumenbach was educated at Jena and Göttingen, becoming professor of medicine at the latter in 1776. From his study of craniology he divided the human species into five classifications—Caucasian, Mongolian, Ethiopian, American and Malayan. His work on comparative anatomy as a basis of zoology was of outstanding merit.

Bode, Johann Elert
German astronomer
b. Jan. 19, 1747, Hamburg
d. Nov. 23, 1826, Berlin
The director of the Berlin Observatory (1786-1825), Bode constructed an atlas of the heavens (*Himmelsatlas*) showing more than 17,000 stars, more than three times as extensive as any up to that time. He also discovered a law, named after him, which is an empirical arithmetical formula giving the approximate distances of the planets from the sun, but having no theoretical foundation. This discovery is also claimed on behalf of J. D. Titius (1729-96). Bode named the planet Uranus and so ended the confusion caused by Herschel's desire to name it Georgium Sidus, or the Georgian.

Bodenstein, Ernst August Max
German chemist
b. 1871, Magdeburg
d. 1940
Educated at Heidelberg, Wiesbaden, Charlottenburg and Göttingen, Bodenstein held many academic appointments before becoming professor of chemistry in Berlin in 1923. He retired in 1936. His original researches include works of reaction kinetics, equilibria and photochemistry.

Bodländer, Guido
German chemist
b. 1855
d. 1904

Professor of chemistry at Breslau, Bodländer investigated the optical properties of solid solutions and mixed crystals. He also did work in connection with affinities from electromotive forces and (in 1902) on complex ions.

Boë, Franz de la. See **Sylvius, Fransiscus.**

Boerhaave, Hermann
Dutch physician
b. Dec. 31, 1668, Voorhout, nr. Leyden
d. Sept. 23, 1738, Leyden
After graduating at Leyden and Harderwyck, Boerhaave became professor of botany and medicine at the former university (1709), also rector and professor of chemistry (1718). He enjoyed an enormous popularity both in his own country and all over the world, and was revered as a great teacher as well as a brilliant worker. His text-book on physiology, *Institutiones Medicae* (1708) was a standard work for many years. Like Descartes he was a mechanist and did not believe in the influence of the mind over the body.

Bogardus, James
American inventor
b. Mar. 14, 1800, Catskill, N.Y.
d. Apr. 13, 1874, New York
Trained as a watchmaker, Bogardus became famous for his many mechanical inventions such as the 'ring flier' (cotton spinning), a dynamometer, pyrometer, drilling machines, dry gas-meter, etc. He erected the first cast-iron building in America.

Bogert, Marston Taylor
American chemist
b. Apr. 18, 1868, Flushing, N.Y.
Educated at Columbia, Bogert rose to be professor of chemistry there in 1904. He was president of the American Chemical Society in 1908, and did research on the synthesis of organic compounds, e.g., the quinazolines and thiazoles. He was a consultant to the U.S. Government on chemical warfare.

Bohr, Niels

Danish physicist

b. Oct. 7, 1885, Copenhagen

Educated at Copenhagen and Cambridge, Bohr worked with J. J. Thomson at Cambridge and with Rutherford at Manchester, before becoming professor of physics at Copenhagen in 1916. He was awarded the Nobel prize for physics in 1922 and became F.R.S. in 1926. He greatly extended the theory of atomic structure when in 1913 he devised an atomic model, and showed that it could explain the spectra of elements and their position in the periodic table. With Sommerfeld he developed the quantum theory, and in *Bohr's theory* shows how it can be applied to atomic structure. Subsequently, with Wheeler, he evolved an important theory of nuclear structure. He escaped from German-occupied Denmark, and in America assisted atom bomb research. After the war he returned to Copenhagen.

Boisbaudran, Paul Émile Lecoq de

French chemist and physicist

b. 1838, Cognac, Charente

d. 1912

Originally in the wine trade, Boisbaudran abandoned this for science, and was the discoverer of the elements gallium, samarium and dysprosium. He was one of the founders of the science of spectroscopy.

Bois-Reymond, Emil du

German physiologist

b. 1818

d. 1896

A pupil of Johannes Müller and professor of physics at Berlin, Bois-Reymond showed that nervous impulses are accompanied by a change of electrical state. With others, he discovered also that chemical changes occur with muscle contraction, the nervous impulse being the trigger action.

Bok, Bart Jan

Dutch-American astrophysicist

b. Apr. 28, 1906, Hoorn

Educated at Leyden and Groningen, Bok went to Harvard in 1933 and became professor of astronomy in 1939. In 1938



NIELS BOHR

he became an American citizen. He is noted for his work on the distribution of the stars, and his work on their movements supports the idea that the age of the universe is about two thousand million years.

Boltwood, Bertram Borden

American physicist

b. 1870, Amherst, Mass.

d. 1927

Educated at Munich, Leipzig, Manchester and New Haven, Boltwood became professor of physics and chemistry at Yale (1910-27). He discovered ionium, the parent of radium, and was the first, in 1905, to suggest that lead is the end product of radioactivity. In 1907, on Rutherford's suggestion, he calculated the age of a mineral from its lead content.

Boltzmann, Ludwig

Austrian physicist

b. Feb. 14, 1844

d. Sept. 5, 1906, Duino

Educated at Linz and Vienna, Boltzmann held various professorships before going to Vienna as professor of physics in 1895. He died by his own hand. An authority on the kinetic theory of gases, he was largely responsible for the spread of Maxwell's electro-magnetic theory on the

BOLYAI

continent. With Stefan he evolved a law named after them, relating to black-body radiation. He contributed to the mechanical theory of heat, and the principle of the equipartition of energy is sometimes known as *Boltzmann's law*. The *Boltzmann constant* ($k = 1.380 \times 10^{-16}$ ergs per degree) is the ratio of the mean total energy of a molecule to its absolute temperature.

Bolyai, János,
Hungarian mathematician

b. 1802

d. 1860

Bolyai's contribution to mathematics is a continuation of the work of his father, Farkas Bolyai (1775-1856), professor of mathematics at Maros-Vásárhely, and was published as an appendix to one of his father's treatises, under the title *Appendix Scientiam spatii absolute veram exhibens* (1831). This presents a generalised non-Euclidean system of geometry very similar to that of Lobachevski (q.v.). Bolyai was perhaps the first to appreciate the importance and potentiality of the new concept.

Bond, William Cranch

American astronomer

b. Sept. 9, 1789, Portland, Maine

d. Jan. 29, 1859, Cambridge, Mass.

Director of Harvard Observatory from 1840, Bond discovered an eighth satellite of Saturn (Hyperion) in 1848 and rediscovered the 'crape' ring of the planet in 1850.

Bond, George Philips

American astronomer

b. May 20, 1825, Cambridge, Mass.

d. Feb. 17, 1865

The son of W. C. Bond (above), he assisted then succeeded him at Harvard Observatory. In 1858 he was the first to suggest the measurement of a star's magnitude by the diameter of its image on a photographic plate.

Borda, Jean Charles

French mathematician

b. May 4, 1733, Dax, Landes

d. Feb. 20, 1799, Paris

Borda served in both the army and the

navy, and was once a prisoner of war of the British but was released immediately. Noted for his researches in hydrodynamics and nautical astronomy, he was also the designer of a number of mathematical instruments which he used in the determination of an arc of the meridian. He was one of those responsible for the introduction of the metric system in France.

Bordet, Jules

Belgian physiologist

b. June 13, 1870, Soignies

Educated at Brussels, Bordet worked in the Pasteur Institute at Paris previous to founding a similar institute in Belgium (1900). An authority on sera, he discovered *alexine*, the active substance which exists before immunisation, and this led him to a general method for the diagnosis of fevers. Among other discoveries of his was the microbe of whooping cough. He was awarded the Nobel prize for medicine and physiology in 1919.

Bosch, Carl

German chemist

b. Aug. 27, 1874, Cologne

d. Apr. 27, 1940

Educated at Charlottenburg and Leipzig, Bosch entered industrial chemistry, becoming president of the I.G. Farbenindustrie, and is noted for his adaptation of his brother-in-law Haber's method of nitrogen fixation. He was thus responsible for the commercial production of ammonia by synthesis, and was awarded the Nobel prize for chemistry with Bergius in 1931 for his part in the invention and development of chemical high-pressure methods. The *Bosch process* prepares hydrogen catalytically from water gas and steam at 500° C.

Boscovich, Ruggiero Giuseppe

Italian mathematician

b. May 18, 1711, Ragusa, Dalmatia

d. Feb. 12, 1787, Milan

After studying at the Collegium Romanum, Boscovich became professor of mathematics there in 1740. In 1764 he went to Pavia as professor of mathematics, be-

came a naturalised Frenchman in 1773, but returned to Italy ten years later. He was a Fellow of the Royal Society. He published a large number of papers on such subjects as gravitation (being the first of Newton's supporters in Italy), telescopic theory, comets, tides, theory of curves and the figure of the earth, and he evolved a molecular theory of matter.

Bose, Sir Jagadis Chandra

Indian physicist

b. Nov. 30, 1858, Vikrampur

d. Nov. 23, 1937, Giridih, Bengal

Educated at Calcutta and Cambridge, Bose became professor of physical science at Calcutta, and he founded the Bose Research Institute there. He was noted for his experiments showing the parallelism between animal and plant life, and conducted some remarkable researches pointing to the possession of the power of feeling in plants, e.g., the quivering of injured plants. He constructed a *crescograph* which magnified small movements of plants ten million times. Among his works are *The Physiology of Photosynthesis* (1924), and *The Nervous Mechanism of Plants* (1926).

Bouguer, Pierre

French mathematician and astronomer

b. Feb. 16, 1698, Croisic

d. Aug. 15, 1758

Professor of hydrography at Havre, Bouguer was associated with Godin and La Condamine in an expedition to South America to measure the length of a degree of the meridian, and wrote *La Figure de la terre déterminée* (1749) giving the results. He invented the heliometer, perfected by Fraunhofer, and his work on light laid the foundation of photometry. He invented a photometer in 1729, the strength of two sources being compared by obtaining equality of illumination on separate halves of a sheet of translucent paper, and used it to compare sun and moon. In 1740 he made the first comparison between the mass of the earth and that of a mountain, and he found that the average for the earth was about twelve times that of Chimborazo in the Andes.

Boulliau, Ismael

French scientist

c. 1650

In 1659 Boulliau constructed the first known example of a thermometer which contained mercury. The credit for this is usually assigned to Fahrenheit who did not construct his thermometers until 1720.

Boussingault, Jean Baptiste Joseph Dieudonné

French chemist and engineer

b. 1802, Paris

d. 1887, Paris

After spending his early life in South America, Boussingault became professor of chemistry at Lyons (1839) and later of agricultural and analytical chemistry at Paris. He showed that plants absorb nitrogen from nitrates in the soil and not from the air, and proved that carbon is assimilated from the carbon dioxide of the atmosphere

Boveri, Theodor

German biologist

b. Oct. 12, 1862, Bamberg

d. Oct. 15, 1915, Würzburg

A pupil of Hertwig, Boveri has added much to our knowledge of cellular structure. In 1888 he introduced the term *centrosome* for a permanent constituent of the animal cell, and in 1892 made a diagrammatic representation of spermatogenesis which is still used. He also did work on abnormal fertilisation.

Bower, Frederick Orpen

English botanist

b. Nov. 4, 1855, Ripon, Yorks.

d. Apr. 11, 1948, Ripon

Educated at Cambridge, Würzburg and Strasbourg, Bower became lecturer in botany at the Imperial College of Science and then professor of botany at Glasgow up to his retirement in 1925. An F.R.S., he was president of the British Association in 1930. Noted for his work on the evolution of land flora, he brought forward a theory which is generally accepted, to account for the gradual increase in importance of asexual generation. Among many publications his latest was *Sixty*



HON. ROBERT BOYLE

Years of Botany in Britain (1938), and the best-known *The Botany of the Living Plant* (1919).

Boyle, The Hon. Robert
Irish chemist

b. Jan. 25, 1627, Lismore Castle
d. Dec. 30, 1691, London

'The father of chemistry and the brother of the Earl of Cork' was the fourteenth child of the first Earl and was educated at Eton. On the death of his father his fortune was lost and he was obliged to live very simply. Much of his early work was done at Oxford with Hooke as assistant, but the latter moved to London. Boyle was one of the original fellows of the Royal Society but he declined the presidency in 1680 as his health was not good and he avoided public life. Some regard him as the founder of modern chemistry because he was a believer in experiment rather than theory, and maintained that chemistry was something more than a subdivision of medical knowledge. He was the first to give a clear definition of an element as the practical limit of chemical analysis, and the first to use the term *analysis*. He believed in a mono-atomic

theory of matter. In 1662 he discovered the law named after him which states that the volume of a gas is inversely proportional to its pressure, and he proposed that a barometer should be used to measure the height of mountains. Probably the first chemist to collect a gas, he was also the first in England to use a sealed thermometer. One of his original suggestions was that alcohol should be used as a preservative for biological specimens, and he was the first to perform the bell-in-vacuo experiment with an efficient air-pump and so to prove conclusively that air is the normal medium by which sound reaches our ears. He also investigated crystals and refraction, specific gravity and electricity.

Boys, Sir Charles Vernon
English physicist

b. Mar. 15, 1855, Wing, Rutland
d. Mar. 30, 1944

Educated at Cambridge and an F.R.S., Boys distinguished himself as a clever and original experimenter. In 1895 he designed a torsion balance which was an improvement on previous models and with this he determined the value of Newton's constant of gravitation, thus arriving at a value of 5.5270 for the mean density of the earth. He invented the radio-micrometer, a combination of a thermocouple and a delicate suspended-coil galvanometer, and with it he was able to measure the heat radiation from the moon and planets. He proved that the temperature of the surface of Jupiter is less than 100°C. He recommended the use of quartz fibres instead of silk for delicate suspension instruments and obtained them by shooting from a bow an arrow with the molten quartz attached. He also designed a calorimeter to measure the thermal power of coal gas, and he designed a camera with moving lens with which he obtained some remarkable photographs of lightning flashes.

Bradley, James
English astronomer

b. 1693, Sherborne, Glos.
d. 1762, Chalford, Glos.

After studying theology at Oxford, Bradley

was ordained, but in 1721 was appointed professor of astronomy at Oxford, and in 1741 he became Astronomer Royal, having been elected F.R.S. in 1718. In 1727 he discovered the aberration of light due to the earth's motion during the year and he measured the velocity of light by observations on this. The value he found was 308,300,000 metres per second. He also discovered the nutation of the earth's axis and did invaluable work on the preparation of astronomical tables. He stated the laws of refraction, and realised the necessity for correcting for temperature and barometric pressure.

Bragg, Sir William Henry

British physicist

b. July 2, 1862, Wigton, Cumberland
d. Mar. 12, 1942

Educated at Cambridge, Bragg became, in 1886, professor of mathematics at Adelaide (S. Australia). In 1909 he returned to Leeds University as Cavendish professor and in 1915 became professor of physics at London University. He was elected F.R.S. in 1906, and in 1915 received the Nobel prize for physics with his son, William Lawrence (below). He was president of the Royal Society from 1935 to 1940. He and his son were famous for their development of the X-ray spectrometer with which they were able to solve many problems concerning the structure of the atom, and the arrangement of atoms in crystals. Apart from his many technical papers Sir William was well-known as a popular writer, two of his works being *The World of Sound* (1920), and *Concerning the Nature of Things* (1925)

Bragg, Sir William Lawrence

British physicist

b. Mar. 31, 1890, Adelaide, S. Aust.

Son of Sir W. H. Bragg, William Bragg was educated at Adelaide and Cambridge. Working with his father, he shared with him the Nobel prize for physics in 1915 for research on X-rays and crystal structure (see above). He became Cavendish professor of experimental physics in 1938, and published among other books *Atomic Structure of Minerals* (1937).

Brahe, Tycho

Danish astronomer

b. Dec. 14, 1546, Knudstrup in Scania

d. Oct. 24, 1601, Benatky, Prague

After studying law at Copenhagen and Leipzig, Brahe finally settled down as an astronomer, and in 1580 built an observatory at Hveen. He left Denmark in 1597 to live at Prague under the patronage of the Emperor Rudolf. Although he wrongly thought the earth the centre of the planetary system, his accurate and painstaking observations were of great value to later astronomers, e.g., they formed the basis for Kepler's laws. He observed a new star in Cassiopeia on Nov. 11, 1572. His principal work was *Astronomiae Instauratae Progymnasmata*, edited by Kepler (Prague, 1602-3).

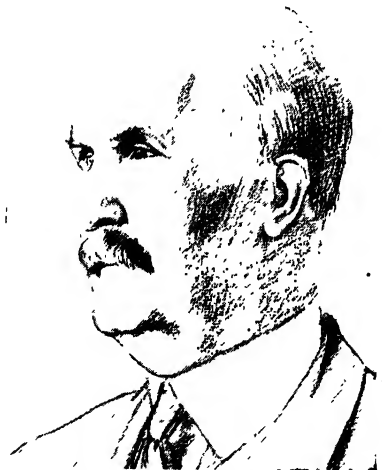
Bramah, Joseph

English engineer

b. Apr. 13, 1748, Stainborough, Yorks.

d. Dec. 9, 1814, London

Trained as a cabinet-maker in London, Bramah invented a patent lock named after him, and followed this by his invention of the hydraulic press. Among other inventions of his may be mentioned a



SIR WILLIAM HENRY BRAGG

BRAND



TYCHO BRAHE

TYCHO BRAHE

printing machine for banknotes, planing machines, bottling machinery and improvements in steam engines. He suggested (1785) the possibility of screw propulsion for ships and, in a lighter vein, patented plans for fountain pens.

Brand, Hennig

German chemist

b. 17th century, Hamburg

A soldier first, Brand turned to alchemy and experimented with urine in the hopes of finding a liquid which would turn silver into gold. This led him to the discovery of phosphorus in 1669.

Brandt, Georg

Swedish chemist

b. 1694, Riddarhytta

d. 1768, Stockholm

Educated at Leyden in medicine and chemistry under Boerhaave, Brandt became director of the chemical laboratory in the Bureau of Mines at Stockholm. He is famous for his discovery of cobalt about 1730, and his industry and perseverance were much admired by his contemporaries.

Braun, Karl Ferdinand

German physicist

b. June 6, 1850, Fulda, Prussia

d. Apr. 20, 1918, New York

Educated at Marburg and Berlin, Braun was professor at the first-named and then held similar appointments before going to Strasbourg in 1895 as professor of physics. His researches on cathode rays and wireless telegraphy earned him the Nobel prize for physics in 1909 (with Marconi).

Brauner, Bohuslav

Czech chemist

b. May 8, 1855, Prague

d. 1935

After studying at Prague, under Bunsen at Heidelberg, and Roscoe at Manchester, Brauner became famous for his investigation of the chemistry of tellurium and the rare earths. He predicted the existence of element No. 61 in 1902, since discovered and named *promethium*, and worked on the periodic table.

Bredig, Georg

German chemist

b. Oct. 1, 1868, Glogau; d. 1944

After working in Leipzig, Bredig became professor of chemistry at Karlsruhe in 1911, and was one of the first to work on the anomalous atomic weight of lead from different sources. He investigated also catalytic action, with special reference to colloidal platinum and the 'poisoning' of catalysts, and the *Bredig method* is the preparation of colloids by electrical disintegration.

Bretonneau, Pierre

French physician

b. Apr. 3, 1778, Tours

d. Feb. 18, 1862

An authority on diphtheria, Bretonneau was the first so to name the disease (*diphthérie*), and he introduced tracheotomy for laryngeal diphtheria. He also stated the germ theory of disease in 1855, and is remembered for his description of typhoid fever.

Breuer, Josef

Austrian neurologist

b. 1842

d. 1925

A co-worker with Freud, Breuer evolved the process called *abreaction*—an hypnotic

method of treatment for neurosis. It is based on the idea that loss of memory, etc., is caused by the suppression of horrible or frightening experiences or memories, and that if these can be forced to the surface under hypnotism, the neurotic condition may be cured. The cure however is not always permanent, and though Freud developed the idea he later rejected it as only partly satisfactory.

Brewster, Sir David

Scottish physicist

b. Dec. 11, 1781, Jedburgh

d. Feb. 10, 1868, Allerby, Melrose

Educated at Edinburgh, Brewster studied for the church but became more interested in science. He held many university appointments and was the moving spirit in the founding, in 1831, of the British Association for the Advancement of Science. He was the editor of the *Edinburgh Encyclopedia*, and became F.R.S. in 1815. In 1811 he discovered the law named after him which states that the tangent of the angle of polarisation is numerically equal to the index of refraction of the reflecting medium, and with Biot he discovered biaxial crystals, that is, crystals with two optic axes. He invented the polyzonal lens for lighthouses in 1835, the kaleidoscope and an improved stereoscope, and suggested a method of producing interference fringes which led to Jamin's interferometer.

Bridgman, Percy Williams

American physicist

b. Apr. 21, 1882, Cambridge, Mass.

Educated at Harvard, Bridgman became professor of physics there in 1919, and of mathematics in 1926. He was awarded the Nobel prize for physics in 1946. Among many researches he showed experimentally that viscosity increases enormously with high pressure (except in the case of water), and he also (in 1921) obtained a new form of phosphorus by heating it at 200° C. under a pressure of 12,000 atmospheres. This was black, graphitic, incombustible and conducted electricity. His work on high-pressure physics and thermodynamics was outstanding. Among his books are *The Logic*

of Modern Physics (1927), *Thermodynamics of Electrical Phenomena in Metals* (1934) and *The Nature of Physical Theory* (1936).

Briggs, Henry

English mathematician

b. 1556, Warley Wood, nr. Halifax

d. Jan. 26, 1630, Oxford

Educated at Cambridge, Briggs became professor of mathematics at Oxford in 1620. Noted for his work on logarithms which did more than anything to popularise their use, he suggested the decimal base instead of the Naperian, and undertook the tedious work of calculating and preparing the tables, which extended to the fourteenth place of decimals. He also introduced the method of long division which is in common use. His *Arithmetica logarithmica* was published in 1624 and the *Trigonometria Britannica* after his death.

Bright, Richard

English physician

b. Sept. 28, 1789, Bristol

d. Dec. 16, 1858, London

Educated at Edinburgh, Bright became assistant physician at Guy's Hospital and was the first to discover the connection



SIR DAVID BREWSTER

BRINELL

between dropsy and the kidney. His researches on kidney disease (*nephritis*) led to his name being attached to it. He collaborated with Addison in the production of a text-book on medicine.

Brinell, Johann August

Swedish engineer

b. 1849

d. 1925

In 1900 Brinell invented a machine, named after him, which measures the hardness of alloys and metals. The Brinell number is a function of the area of indentation produced on the surface of the metal or alloy by a hardened steel ball under standard load.

Brisbane, General Sir Thomas
Makdougall

Scottish astronomer and soldier

b. July 23, 1773, Largs, Ayrshire

d. Jan. 27, 1860, Largs

Entering the army, Brisbane had a distinguished career as a soldier before becoming governor of New South Wales. While in Australia he established an observatory at Paramatta, where the work for the great Brisbane catalogue of over 7,000 stars was carried out. He later returned to Scotland and continued at the Makerstoun Observatory in Roxburghshire, where he made important magnetic observations. Brisbane, the capital of Queensland, was named after him.

Briscoe, Henry Vincent Aird

English chemist

b. Sept. 24, 1888, Hackney, London

After studying at London, Briscoe lectured there in engineering chemistry and later at Armstrong College, Newcastle-on-Tyne. He eventually became director of the inorganic and physical chemical laboratories at the Imperial College of Science. He has done much original work on inorganic chemistry and in particular on boron, rhenium and selenium.

Broca, Paul

French surgeon

b. June 28, 1824, Sainte-Foy la Grande, Gironde

d. July 9, 1880

Educated in Paris, Broca became professor of surgical anatomy there in 1849, and later founded the Anthropological Society. An authority on aphasia he was the first to localise cerebral functions by his discovery of the motor speech centre, and he did research also on prehistoric surgical operations (trephining).

Broglie, Louis Victor de. See **de Broglie**

Broglie, Maurice, Duc de. See **de Broglie**

Brongniart, Alexandre

French geologist

b. 1770, Paris

d. 1847, Sèvres

After being director of the porcelain manufactory at Sèvres, Brongniart became, in 1822, professor of mineralogy at the Museum of Natural History. He was the first to introduce the term *Jurassic* (from the Jura Mts.) for the limestones and clays of the Cotswolds to which William Smith had given local names.

Brönsted, Johannes Nicolaus

Danish chemist

b. 1879, Varde

Educated at Copenhagen, Brönsted became professor of chemistry there and director of the Physico-chemical Institute. He did much distinguished research work on the kinetic properties of ions, catalysis and nitramide.

Brouncker, William, Viscount

Irish mathematician

b. 1620

d. Apr. 5, 1684, London

Educated at Oxford, Brouncker was one of the most brilliant mathematicians of his time, a close friend of Pepys, and a founder of the Royal Society, of which he was first president. He is remembered for his use of infinite series to express quantities which he could not determine, e.g., he evolved the continued fraction :—

$$\frac{\pi}{4} = \frac{1}{1+} \frac{1^2}{2+} \frac{3^2}{2+} \frac{5^2}{2+} \text{ etc.}$$

Brown, Alexander Crum

Scottish chemist

b. Mar. 26, 1838, Edinburgh*d.* Oct. 28, 1922

Educated at Edinburgh, London, Heidelberg and Marburg, Crum Brown was professor of chemistry at the first-named until 1908. He was elected F.R.S. in 1879 and is noted for his work on the theory of isomerism and the organic compounds of sulphur. Crum Brown's rule, relating to substitution in benzene derivatives, is named after him, and in 1864 he devised modern structural formulae.

Brown, Robert

Scottish botanist

b. Dec. 21, 1773, Montrose*d.* June 10, 1858, London

After studying medicine at Edinburgh, Brown was naturalist in Flinders' expedition to Australia in 1800, and brought back 4,000 species of plants. He wrote a book on the natural history of New Holland and Van Diemen's Land. He was the first English writer to use the natural system of classification in place of that of Linnaeus. He became an F.R.S. in 1811, and in 1827 was keeper of botany at the British Museum. In the same year he was the first to notice the movement of particles in a colloidal solution, since called the *Brownian movement*, giving direct experimental evidence as to the molecular structure of liquids. He was awarded the Copley medal in 1839.

Brownrigg, William

English chemist

b. Mar. 24, 1711, High Close Hall, Cumberland

d. Jan. 6, 1800, Ormathwaite, Cumberland
After studying medicine in London and Leyden, Brownrigg settled as a doctor at Whitehaven. He conducted many researches on gases, but his results were never widely known as he was extremely modest about his discoveries. In 1741 he was probably the first to think of a pneumatic trough for the collection of gases over water. He was one of the first to describe platinum, a specimen of which a relative sent him from Jamaica.

Brown-Séguard, Charles Edward

British physiologist

b. Apr. 8, 1817, Port Louis, Mauritius*d.* Apr. 2, 1894, Sceaux

Of American-French parentage, Brown-Séguard was educated in Paris and was professor there after being at Harvard. He eventually became professor of experimental medicine at the Collège de France. He did important work on the spinal cord but is best known perhaps for his study of internal secretions which led to useful treatment for myxoedema (degeneration of the thyroid gland). An unfortunate suggestion of his, made in old-age, concerning the use of an animal fluid from sheep's testicles for the prolongation of life led to violent and somewhat undeserved criticism from other scientists.

Bruce, Sir David

British physician

b. May 29, 1855, Melbourne, Aust.*d.* Nov. 27, 1931

Educated at Edinburgh, Bruce became an army medical officer. He is remembered for his pioneer work on sleeping-sickness, and in particular for his discovery of the part played by the tsetse fly as a carrier.

Brunel, Sir Marc Isambard

French engineer

b. Apr. 25, 1769, Hacqueville, Normandy*d.* Dec. 12, 1849, London

Leaving France on account of his royalist sympathies, Brunel lived for a time in New York, working as an architect and engineer. In 1799 he came to England and was the first to attempt the production of a complete set of machine tools, in this case connected with ship-building. As well as producing a large number of small inventions (copying machines, sawing machines, nail manufacture, etc.) he was responsible for the Wapping-Rotherhithe tunnel under the Thames.

Brunel, Isambard Kingdom

English engineer

b. Apr. 9, 1806, Portsmouth*d.* Sept. 15, 1859, Westminster

Son of Sir Marc, Isambard Brunel was educated at Paris and like his father

BRUNSCHWIG

became an outstanding engineer and inventor. Many of the great bridges of England are his work (for example, the Clifton suspension), and he was intimately connected with the laying of the G.W.R., originating the broad gauge. He designed the first transatlantic steamship, the *Great Western*, the first screw steamship, the *Great Britain* and the famous *Great Eastern*, though he did not live to see the success of the latter, the largest steamship of its day. See I. Brunel, *The Life of I. K. Brunel* (1870).

Brunschwig, Hieronymus
German surgeon

c. 1497

Brunschwig was an Alsatian army surgeon, and in 1497 wrote the first description of gunshot wounds. He lived in Strasbourg and there published his *Buch der Chirurgia* in folio with wood-cut illustrations. A herbal which appeared in several different editions is also attributed to him.

Buch, Christian Leopold, Baron von
German geologist

b. Apr. 26, 1774, Stolpe, Pomerania
d. Mar. 4, 1853, Berlin

After his education at Freiburg under Werner and at Halle and Göttingen, Buch carried out geological exploration with Humboldt. He made important observations on volcanoes and demonstrated the slow rise of the whole of the land mass of Sweden (isostasy). In 1832 he produced a magnificent geological map of Germany; he was a plutonist and probably the greatest geologist of his age.

Buchan, Alexander

b. Apr. 11, 1829, Kinnesswood, Kinross
d. May 13, 1907, Edinburgh

After leaving Edinburgh University, Buchan became a school-teacher, and in 1860, secretary of the Scottish Meteorological Society. In 1867 his famous *Handy Book of Meteorology* appeared, and in 1869 the important paper on "Mean Pressure and Prevailing Winds of the Globe" (*Trans. Roy. Soc. Edin.*), a theme further elaborated in his "Report on Atmospheric Circulation" (*Challenger Reports*, ii, 5, 1889). He

was elected F.R.S. in 1898. His careful correlations of data of mean temperature, isobaric lines, prevailing winds, atmospheric pressure, mean specific gravity of oceans, and other factors, discussed in a long and distinguished series of papers, did much to advance the scientific study of meteorology. Buchan cold and warm spells are nine 'anomalies' (as he called them) which he observed in Scottish thermometric records and which break more or less regularly the seasonal rise and fall of temperature. For Scotland he tabulated them as: *cold*, Feb. 9-14, April 11-14, May 9-14, June 29-July 4, August 6-11, Nov. 6-13; *warm*, July 12-15, August 12-15, December 3-14.

Buchner, Eduard

German chemist

b. May 20, 1860, Munich

d. Aug. 24, 1917 (killed in war)

Leaving a commercial career to study chemistry and botany at Munich, Buchner became professor at Berlin, Breslau and finally at Würzburg in 1911. He was awarded the Nobel prize for chemistry in 1907 for his work on alcoholic fermentation. He showed that this is due to the action of enzymes in the yeast and not to physiological processes in the yeast cells.

Buffon, Georges Louis Leclerc, Comte de
French naturalist

b. 1707, Montbard, Côte d'Or
d. 1788, Paris

After studying law at Dijon and later inheriting a fortune, Buffon devoted himself to scientific works. He became keeper of the Jardin du Roi and settled down to the production of a monumental work on natural history in forty-four volumes which took fifty-five years to produce, being finished after his death by an assistant. He was a member of the French Academy and an F.R.S., and without being an original discoverer made notable contributions to scientific literature on account of his lucid and attractive style. An evolutionist, he had some appreciation of the length of geological eras and was the first to throw doubt on the age of the earth according to

Biblical evidence. His only son was a victim of the guillotine in 1793.

Bunsen, Robert Wilhelm Eberard

German chemist

b. Mar. 31, 1811, Göttingen

d. Aug. 16, 1899, Heidelberg

After studying at Göttingen, Paris, Berlin and Vienna, Bunsen eventually became professor of chemistry at Heidelberg in 1852. One of the greatest chemists of all time, he shares with Kirchhoff the credit for the discovery of spectrum analysis in 1859, leading to his discovery of the elements caesium in 1860, and rubidium in 1861. He isolated free cacodyl, but in the course of his experiments with it he partially lost the sight of one eye. This caused him to abandon the study of organic chemistry and he also forbade its study in his university laboratories. He invented a galvanic battery, the well-known bunsen burner, the filter pump, and with Roscoe, the actinometer. His experiments on the variation of melting point with pressure were accompanied by a very accurate determination of the expansion of water on solidification, and he constructed an ice-calorimeter which is of great use for the determination of specific heats of substances in short supply, e.g., diamond. A grease-spot photometer which makes use of the fact that a grease-spot on a sheet of paper is invisible when equally illuminated from each side, was another of his inventions.

Burbank, Luther

American biologist

b. Mar. 7, 1849, Lancaster, Mass.

d. Oct. 11, 1926, Santa Rosa, California

Educated at the Lancaster Academy, Burbank became a plant-breeder and experimented on crossing and in-breeding of varieties. He lectured on evolution at Stanford University. He produced a white blackberry after 5,000 unsuitable crossings, also an edible spineless cactus, and he improved plums, berries, tomatoes, corn, lilies, roses, etc.

Bussy, Antoine Alexandre Brutus

French chemist

b. 1794, Marseilles

d. 1882, Paris

After studying at the École Polytechnique for the army, Bussy abandoned a military career for pharmaceutical chemistry and became professor of chemistry at the École de Pharmacie in Paris. In 1831 he discovered a method of producing magnesium metal in reasonable quantities by heating together magnesium chloride and potassium. In 1828 he prepared metallic beryllium, independently of Wöhler.

Butenandt, Adolf Friedrich Johann

German chemist

b. Mar. 24, 1903, Wesermünde

Educated at Wesermünde, Marburg and Göttingen, Butenandt became director of Danzig Institute of Organic Chemistry and (1937) of the Kaiser Wilhelm Institute, Berlin. Noted for his work on sex hormones and in particular for his isolation of androsterone and work on the chemical structure of progesterin, he was offered the Nobel prize for chemistry in 1939. He declined on account of the Nazi decree against foreign awards. See Ružička.

C

Cadet de Gassicourt, Louis Claude

French chemist

b. 1731, Paris

d. 1799

Cadet was a member of the Academy of Sciences who produced in 1760 what is probably the worst smell in chemistry, the heavy, brown, strongly fuming liquid of fearful odour, from which Bunsen isolated cacodyl oxide. Berzelius named it from the Greek word for 'stinking'. Cadet's liquid was made by distilling a mixture of equal weights of potassium acetate and arsenious oxide.

Cagniard de la Tour, Charles

French physicist

b. Mar. 31, 1777, Paris

d. July 5, 1859, Paris

Educated at Paris, Cagniard was the inventor and namer of the *siren*, which he used to measure the numbers of vibrations in various pitches. He is also remembered as the constructor of a piece of apparatus used for the determination of the critical temperature of a liquid.

Cahours, Auguste

French chemist

b. 1813

d. 1891

A professor of chemistry at Paris, Cahours is remembered as the discoverer of amyl alcohol, allyl alcohol, anisol and tin tetraethyl.

Cailletet, Louis Paul

French ironmaster

b. Sept. 21, 1832, Châtillon-sur-Seine

d. Jan. 5, 1913, Châtillon-sur-Seine

In 1877, carrying out researches on the liquefaction of gases, Cailletet liquefied for the first time hydrogen, nitrogen, oxygen and air by compression, cooling and sudden expansion. Pictet accomplished this at about the same time.

Caius, John (Key or Kaye)

English physician

b. Oct. 6, 1510, Norwich

d. July 29, 1573

Educated at Gonville Hall, Cambridge, Caius studied under Vesalius at Padua and became physician to Edward VI, Mary and Elizabeth. He was responsible for the enlargement of Gonville Hall into Gonville and Caius College, and furthered the study of anatomy there by securing the bodies of two criminals per year for dissection. He wrote several scientific works, the best-known being *A Boke of Counseill against the Sweat and Sweating Sickness* (1552).

Callendar, Hugh Longbourne

English physicist

b. 1863, Hatherop, Glos.

d. Jan. 21, 1930, London

Educated at Cambridge, Callendar became professor of physics at McGill University, Montreal, in 1893, at University College, London, in 1898, and at the Imperial College of Science in 1902. He did a considerable amount of research on steam-engines, and in 1899 with Barnes, he conducted a series of experiments on the specific heat of water. He devised a constant pressure air-thermometer which could measure up to 450° C. with an accuracy of 1/10 degree, and he also constructed an accurate platinum resistance thermometer.

Camerarius, Rudolf Jacob

German botanist

b. Feb. 12, 1665, Tübingen

d. Sept. 11, 1721, Tübingen

A professor of medicine and director of the botanical gardens at Tübingen, Camerarius was the first to give a clear account of the idea of sex in plants. This he did in a short paper *De sexu plantarum epistola*, published in 1694, and based on experimental evidence. He was unable to account for non-flowering plants.

Candolle, Augustin Pyrame de
Swiss botanist

b. Feb. 4, 1778, Geneva

d. Sept. 9, 1841, Geneva

Educated at Geneva, de Candolle produced several works on botany in which he introduced a new system of classification opposed to the Linnean system. After making a botanical survey of France at the request of the government, he lectured at Montpellier before returning to Geneva as professor of natural history.

Cannizzaro, Stanislao

Italian chemist

b. July 13, 1826, Palermo

d. May 9, 1910, Rome

After studying in Palermo and Naples, Cannizzaro became professor of chemistry at Genoa, Palermo and finally Rome. He was awarded the Copley medal in 1891. In 1860 when at Genoa he marched with Garibaldi's Thousand. He was the first (in 1854) to realise the importance of Avogadro's work and its connection with atomic weights, and he obtained its universal acceptance. He also did important work in organic chemistry, producing benzyl alcohol and benzoic acid; he discovered the reaction named after him, and showed conclusively that organic and inorganic are one chemistry and not two.

Canton, John

English physicist

b. July 31, 1718, Stroud

d. Mar. 22, 1772, London

Though apprenticed to a weaver, Canton was led by his interest in science to become a schoolmaster; he was elected F.R.S. in 1749, gaining the Copley medal in 1751. He was the first to demonstrate the electrification of air and was the first to make powerful artificial magnets. He also investigated phosphorescence in the sea and traced it to the decomposition of animal matter. He proved that water could be compressed, the first experimental proof.

Cardano, Girolamo or Geronimo

Italian mathematician and physician

b. Sept. 24, 1501, Pavia

d. Sept. 21, 1576, Rome

The illegitimate son of a Milan jurist, Cardano was educated at Pavia and Padua in medicine but was unable to enter the college of physicians because of his birth. His work, however, eventually gained him recognition and he became professor of medicine at Pavia in 1544 and later at Bologna. It is in the realm of mathematics, however, that Cardano is best known, his works on algebra bringing him European fame. He was not always entirely honest, however, in his writing, as he published in *Ars magna* (1545) the cubic solution though he had obtained it from Tartaglia under a promise of secrecy. In common with most scientific men of his age he held many erroneous beliefs about creation. The Cardan shaft used in the motor car is a discovery of his. He wrote on medicine, astrology and astronomy and his books, *De subtilitate rerum* (1551) and *De varietate rerum* (1557), survey the scientific and physical theories of the times. His later life was embittered by the execution of his son (1560) for the poisoning of his, the son's, wife, and by his own arrest and loss of position in 1570. He was a man who created more enemies than friends.

Carnot, Nicolas Léonard Sadi

French soldier and scientist

b. 1796, Paris

d. Aug. 24, 1832, Paris

An officer in the French army, Carnot did research work on heat engines and deduced the principle named after him which states that all reversible heat engines possess the same efficiency when absorbing and rejecting heat at the same two temperatures. His booklet, *Réflexions sur la puissance motive du feu* is the basis of thermodynamics and was called 'one of the greatest things in science'. He died of cholera.

Carothers, Wallace Hume

American chemist

b. 1896 Burlington, Iowa

d. 1937

Educated at Tarkio College and Illinois, Carothers became first a teacher and then research chemist with Du Pont de Nemours. An expert on plastics, he was the

CARREL

inventor of Nylon, the patent being granted to the company in 1937 after his death. This substance was a development of the synthetic superpolyamides.

Carrel, Alexis

French biologist

b. June 28, 1873, Ste. Foy-lès-Lyons

d. Nov. 5, 1944, Paris

Educated at Lyons University, Carrel did research work there and also at the University of Chicago. He became a member of the Rockefeller Institute for Medical Research in New York in 1912, in which year he was awarded the Nobel prize for physiology and medicine. One of his discoveries was a method of suturing blood-vessels so making it possible to replace arteries. With Dakin he devised a new treatment for wounds which avoided numberless amputations, and he also did much work on the prolongation of the life of tissues. In this connection he succeeded in keeping alive a fragment of a chicken's heart for an indefinite period by carefully removing wastes, and pruning to control the growth of the cells.

Carrington, Richard Christopher

English astronomer

b. May 26, 1826, Chelsea

d. Nov. 27, 1875, Churt, Surrey

Educated at Cambridge, Carrington became observer at Durham University Observatory in 1849. He later erected a private observatory at Redhill, Surrey. Between 1853 and 1861 he made important observations on sun-spots and showed that the rotational period of the spots varies with their latitude. He became an F.R.S. in 1860, and died in tragic circumstances

Carroll, James

English physician

b. 1854, Woolwich

d. 1907

After going to Canada and the U.S.A. in early life, Carroll served in the American army as a surgeon and was associated with Reed in his work on yellow fever. He infected himself with the disease to show that it was caused by a virus carried by a mosquito. In 1902 he became professor of

bacteriology and pathology at Columbia and the Army Medical School.

Cartwright, Edmund

English inventor

b. Apr. 24, 1743, Marnham, Notts.

d. Oct. 30, 1823, Hastings

Educated at Oxford, Cartwright entered the church and became a country clergyman. Developing an interest in machine weaving, he invented a power-loom, the prototype of the modern loom, a wool-combing machine and other machines, but none brought him the financial security he might have expected. One of his mills in Manchester was wrecked in the anti-machine riots. Eventually the government made him a grant of £10,000 and he purchased a farm in Kent. His inventions included some agricultural implements

Cassegrain, N.

French physician

c. 17th century

A professor at the Collège de Chartres, Cassegrain was the inventor in 1672 of a particular kind of reflecting telescope. In this the rays from the speculum are reflected through a hole in its centre by a small convex mirror, the telescope thus giving vision in the line of sight as in a refractor. Though not popular at the time, its shortness combined with a large effective focal length has resulted in a revival of its construction. Cassegrain also wrote a treatise on megaphones. See J. Gregory.

Cassini, Giovanni Domenico, or Jean Dominique

Italian-French astronomer

b. June 8, 1625, Perinaldo, Nice

d. Sept. 11, 1712, Paris

Educated at Genoa, Cassini was professor of astronomy at Bologna before becoming a French subject in 1673. He was later director of the Paris Observatory. Among his many discoveries were four new satellites of Saturn, the zodiacal light, the obliquity of the ecliptic and the division in the ring of Saturn which has since carried his name. He showed the cause of the moon's libration and measured the rotation periods of Venus, Mars and

Jupiter. Only Hooke preceded him in his observation of the famous spot on Jupiter, possibly the one which sprang into prominence again towards the end of the last century. With his son (see below) he conducted a series of pendulum experiments which suggested the true shape of the earth as a prolate spheroid (the rotation of an ellipse around its major axis). It was later established as an oblate spheroid (rotation round a minor axis). His rejection of Roemer's discovery of a finite velocity for light was an unfortunate error for French science.

Cassini, Jacques

French astronomer

b. Feb. 8, 1677, Paris

d. Apr. 18, 1756, Thury, nr. Clermont

The son of Giovanni (see above), Cassini succeeded his father as director of the Paris Observatory and continued his work on Saturn. He did some notable work on the figure of the earth.

Cassini de Thury, César François

French astronomer and geographer

b. June 17, 1714, Paris

d. Sept. 4, 1784, Thury

The son of of Jacques (see above), Cassini followed his father as director of the Paris Observatory. He is noted for his topographical map of France, begun in 1744 and completed by his son (see below).

Cassini, Jacques Dominique de (Comte)

French mathematician and geographer

b. June 30, 1748, Paris

d. Oct. 18, 1845, Thury

The son of César (see above) he succeeded his father at the Paris Observatory and completed his map of France. He was imprisoned for a time during the revolution.

Cassini, Alexandre Henri Gabriel de (Vicomte)

French botanist

b. 1784

d. 1832

The son of Jacques Dominique (see above), he broke the succession of astronomers and turned to botany. He wrote a book entitled *Opusculs Phytologiques* in 1826.

Castle, William Ernest

American biologist

b. Oct. 25, 1867, Alexandria, Ohio

Educated at Harvard, Castle became professor of geology there in 1897, and of genetics from 1908 to 1936. Using piebald hooded rats, he conducted some important experiments on natural selection, which show the importance of mutation in the alteration of a species. He is the author of several books on this subject.

Castner, Hamilton Young

American chemist

b. 1859, Brooklyn, N.Y.

d. 1899

Educated at Columbia, Castner came to England as an analytical chemist and was the inventor of a new process for the isolation of sodium from brine by electrolysis. With Kellner he founded a company to work the process.

Cataldi, Pierre Antoine

Italian mathematician

b. 1548

d. 1626

Cataldi is one of the early mathematicians who devoted many years to numerical calculations. In 1613 he evolved continued fractions which he used mainly for extracting square roots. He was a professor of the University of Bologna, where he founded one of the first mathematical academics.

Cauchy, Augustin Louis, Baron

French mathematician

b. Aug. 21, 1789, Paris

d. May 23, 1857, Sceaux, Seine

Cauchy studied at the École Polytechnique, turning from engineering to mathematics on account of his health. From the chair of mathematics in Paris, he went to Turin and later returned to the École Polytechnique, his career being interrupted by political differences with the authorities. He is famous for his work on wave propagation, on the calculus, and on elasticity; his complete works occupy twenty-seven volumes.

CAVENDISH

Cavendish, Henry

English physicist and chemist

b. Oct. 10, 1731, Nice

d. Feb. 24, 1810, Clapham, London

The son of Lord Charles Cavendish and grandson of the Duke of Devonshire, Cavendish was educated at Cambridge. Though a very wealthy man, leaving over a million pounds, he was extremely shy, living the life of a recluse and devoting himself entirely to science. The Cavendish laboratory is named after him. In 1766 he discovered the properties of hydrogen which he identified as an element, and in 1781 determined the composition of the atmosphere. This was followed in 1784 by his investigation of the composition of water which he made synthetically for the first time. He believed that heat was caused by the internal motion of particles, but attributed this idea to Newton instead of to Francis Bacon. In 1797 he was the first to measure Newton's constant of gravitation with a piece of apparatus resembling the torsion balance, and he was thus able to calculate the mean density of the earth as 5.448 (*cp.* Boys' 5.5270).

Caventou, Joseph Bienaimé

French chemist

b. 1795

d. 1878

In collaboration with Pelletier in 1817 Caventou introduced the term *chlorophyll* into biology, and they also made the important discoveries of quinine and strychnine, brucine and cinchonine. He was a professor at the École de Pharmacie, Paris.

Cayley, Arthur

English mathematician

b. Aug. 16, 1821, Richmond, Surrey

d. Jan. 26, 1895, Cambridge

Educated at Cambridge, Cayley became senior wrangler and then studied for the bar. He was later elected professor of mathematics at Cambridge. In mathematics he created the theory of matrices and his work on quantics, the theory of groups, and a multiplicity of problems connected with dynamics and astronomy was outstanding. In private life he was

much respected and gained almost every possible scientific honour and distinction.

Celsius, Anders

Swedish astronomer

b. Nov. 27, 1701, Uppsala

d. Apr. 25, 1744, Uppsala

Professor of astronomy at Uppsala, Celsius constructed the centigrade thermometer in 1742. This frequently still carries his name, though he marked the boiling point 0 and the freezing point 100. A colleague, Martin Stromer, inverted the scale eight years later.

Cesalpini, Andrea

Italian botanist

b. 1519

d. 1603

A professor at Pisa, Cesalpini was one of the first to attempt a classification of plants. Arranging them according to their fruits and flowers he made a complete classification which he published in Florence in 1583 under the title *De Plantis*. It had considerable influence on later classifications.

Ceulen, Ludolph van

Dutch mathematician

b. Jan. 28, 1540, Hildesheim

d. Dec. 31, 1610, Leyden

A professor of fortification at Leyden, Ceulen devoted almost his whole life to finding the value of π , and in 1610 had worked it out to 35 decimal places. This was known as *Ludolph's number*.

Ceva, Giovanni

Italian mathematician

b. 1647 (?), Milan

d. 1734

One of two brothers, both mathematicians, he gave his name to a theorem in connection with the concurrency of straight lines through the vertices of a triangle. This theorem is stated in his *De lineis rectis se invicem secantibus constructio statica* which was published in Milan (1678). His brother Tommaso (b. Dec. 20, 1648, Milan; d. Feb. 3, 1736, Milan), published *Opuscula Mathematica* in 1699.

Chabaneau, François

French chemist

b. 1754, Nontron, Charente

d. 1842, Nontron

In his early youth Chabaneau studied theology but was expelled from the school on account of his views on metaphysics. At the early age of seventeen he became professor of mathematics at Passy, a position he accepted from sheer necessity as he was ignorant of the subject, but it turned him to the study of physics and chemistry. He eventually became professor of mineralogy, physics and chemistry at Madrid and here he conducted his famous researches on platinum. Despite many setbacks he was able finally to produce an ingot of malleable platinum in 1783.

Chadwick, Sir James

English physicist

b. Oct. 20, 1891, Manchester

Educated at Manchester, Berlin and Cambridge, Chadwick worked with Rutherford at Manchester and at the Cavendish Laboratory. Subsequently he accepted the post of professor of physics at Liverpool, and later was put in charge of the atomic energy station at Didcot. He was elected an F.R.S. in 1927. In 1932 he discovered the neutron by bombarding beryllium with alpha particles, and in 1935 he was awarded the Nobel prize for physics. He worked also on the scattering of alpha-particles, and on nuclear disintegration.

Chain, Ernst Boris

German pathologist

b. June 19, 1906, Berlin

Educated at Berlin and at Cambridge under F. G. Hopkins, Chain became lecturer in chemical pathology at Oxford. He was obliged to leave Germany in 1933 owing to racial persecution. He is noted for his association with H. W. Florey in the development of penicillin as a curative agent, and was a Nobel prize winner for physiology and medicine in 1945.

Chamberland, Charles Édouard

French bacteriologist

b. 1851

d. 1908

A collaborator with Pasteur, Chamberland

is remembered as the inventor of the unglazed porcelain filter which has become generally used in laboratories.

Chamberlin, Thomas Chrowder

American geologist

b. Sept. 25, 1843, Mattoon, Ill.

d. Nov. 15, 1928, Chicago

Educated at Beloit College, Chamberlin became professor of geology there and later chief geologist of the Wisconsin Geological Survey. After holding other important appointments he became professor of geology at Chicago. His most famous work was in connection with the fundamental geology of the solar system, i.e., the problems connected with the planetesimal hypothesis, comets, meteorites, nebula theory of solar origin, etc. Among many books of his are *The Origin of the Earth* (1916) and *The Two Solar Families, The Sun's Children* (1928). He was founder and editor of the *Journal of Geology*. See Moulton, F. R.

Chamisso, Louis Charles Adelaide de

German poet and biologist

b. 1781, Boncourt, Champagne

d. Aug. 21, 1838, Berlin

The son of French parents who fled to Berlin during the revolution, Chamisso became a page to the queen and then entered the army. He was the author of a well-known story concerning the man who sold his shadow. He studied biology, and was the first, in 1819, to discover in certain animals the peculiarity which he called 'alternation of generations'. This refers to the recurrence in the life-cycle of two or more forms. Steenstrup continued this study.

Chancourtois, Alexandre Émile Béguyer de

French geologist

b. 1819

d. 1886

Professor of geology at the School of Mines in Paris, Chancourtois was one of the first to suspect periodicity in the elements. He arranged the elements spirally on a cylinder and noted that vertical lines covered elements which were related, e.g., the

CHAPLIN

halogens. His work passed unnoticed at the time.

Chaplin, Matilda, see **Ayrton, W. E.**

Chaptal, Jean Antoine Claude, Comte de Chanteloup

French chemist

b. June 4, 1756, Nogaret, Lozère

d. July 30, 1832, Paris

After studying medicine and natural science, especially chemistry, Chaptal became professor of chemistry at Montpellier and he introduced into the latter science, in 1790, the name 'nitrogen'. He was a supporter of the revolution and became a member of the Senate, introducing the metric system of weights and measures. He also furthered the study of applied chemistry, e.g., in viticulture, and dyeing.

Charcot, Jean Martin

French physician

b. Nov. 29, 1825, Paris

d. Aug. 16, 1893

Educated at Paris, Charcot became professor of pathological anatomy in the medical faculty there. His research into hysteria and its causes led him to the question of hypnotism in relation to these conditions, and he was an authority on all types of nervous paralysis. Under his direction the Salpêtrière became the most famous neurological clinic of the time. His medical work also included the study of cerebro-spinal sclerosis (Charcot's disease), pneumonia, tuberculosis, gout and many other diseases.

Charles, Jacques Alexandre César

French physicist

b. Nov. 12, 1746, Beaugency, Loiret

d. Apr. 7, 1823, Paris

Professor of physics in Paris, Charles was the discoverer of the law named after him connecting the expansion of a gas with its rise in temperature. He did not publish his results but they came to the notice of Gay-Lussac who was working on the same subject and came to the same conclusion. He was one of the first to make a balloon ascent, a practical application of his

interest in gases, as he was the first to use hydrogen in balloons (1783).

Charles, Michel

French mathematician

b. Nov. 15, 1793, Épernon

d. Dec. 18, 1880, Paris

Educated in Paris, Charles left a business career for mathematics and became professor at the Sorbonne. Independently of Steiner he developed projective geometry and his *Aperçu historique sur l'origine et la développement des méthodes en géométrie* (1837) is a classic.

Chatelier, Henry Le

French chemist

b. 1850

d. 1936

Professor of chemistry in Paris, Le Chatelier investigated the specific heats of gases at high temperatures, mass action in explosion reactions, freezing point curves and the chemistry of silicates. In 1888 he discovered the law of reaction governing the effect of pressure and temperature on equilibrium: if a constraint is placed on a system in equilibrium the system tends to adjust itself so as to offset the constraint. He devised also an optical pyrometer, and a railway water-brake, and made important contributions to metallurgy and ceramics.

Cherwell, Frederick Alexander Lindemann, Baron

English physicist

b. 1886, Sidmouth

Educated at Darmstadt, Berlin and Paris, a fellow of the Royal Society, Lindemann has been professor of experimental philosophy at Oxford since 1919. He was an experimental pilot and director of the Physical Laboratory of the R.A.F. at Farnborough during the Great War (1914-18), and personal assistant to Mr. Churchill in 1940. Noted for his work on the quantum theory, he has published a wide range of papers on physical, chemical and astro-physical subjects, including *The Physical Significance of the Quantum Theory*. His work on conditions in the upper atmosphere has proved of great importance

with regard to flight at high altitudes, and he has investigated the mechanisms of reaction in the gas phase.

Cheselden, William

English surgeon

b. Oct. 19, 1688, Somerby, Lincs.

d. Apr. 10, 1752, Bath

After studying anatomy in London under Cowper, Cheselden became surgeon at St. Thomas's and St. George's hospitals. One of the first surgeons to perform the 'lateral operation for stone' (lithotomy), he also broke new ground in his production of artificial pupils (iridotomy) as a cure for certain types of blindness. He was an excellent draughtsman, and designed Fulham Bridge (1729, wooden).

Chevreur, Michel Eugène

French chemist

b. Aug. 31, 1786, Angers, Maine-et-Loire

d. Apr. 9, 1889, Paris

After being director of dyeing in the Gobelins works, Chevreul became in 1830 professor of chemistry at the Collège de France and lived a full life to the age of 102. His work on dyes and the physics of colour was outstanding. He was mostly connected with the technical side of chemistry, and investigated oils and fats and the formation of soap, discovering stearin and margarine. He was one of the founders of modern organic chemistry. *The Law of Simultaneous Contrast of Colours* (1839) was his most important work.

Chittenden, Russell Henry

American physiologist

b. Feb. 18, 1856, New Haven, Conn.

d. 1943

Educated at Yale and Heidelberg, Chittenden became professor of physiological chemistry at the former university and later director of the Sheffield Scientific School. His researches on diet and digestion were landmarks in the study of physiological chemistry and he may be said to be one of the founders of this branch of medicine in America. He wrote *Physiological Economy in Nutrition* (1905) and *Nutrition of Man* (1907).

Chladni, Ernst Florens Friedrich

German physicist

b. Nov. 30, 1756, Wittenberg

d. Apr. 3, 1827, Breslau

Educated as a lawyer, Chladni turned to science and became a pioneer in the science of sound. He earned a living by giving musical performances and scientific lectures, and was the inventor of the euphonium, upon which he performed during his many travels in Europe. He discovered the longitudinal vibrations in a string or rod, and conducted experiments on the vibration of plates by sprinkling them with sand and bowing the edges. The patterns so produced are known as Chladni's figures. He is regarded as one of the founders of the science of acoustics.

Christiansen, Christian

Danish physicist

b. 1843, Lørborg

d. 1917, Copenhagen

Christiansen became professor of physics at Copenhagen in 1886; he had previously verified Sellmeier's theory of anomalous dispersion by experiments on the refractive index of fuchsine (magenta).

Christie, Samuel Hunter

English mathematician

b. Mar. 22, 1784, London

d. Jan. 24, 1865, Twickenham, Middlesex

Educated at Cambridge and later professor of mathematics at Woolwich, Christie suggested the balance of four resistances which led Wheatstone to invent his famous bridge for measuring resistances. His son, Sir W. H. M. Christie, was Astronomer Royal from 1881-1901.

Chuquet, Nicolas

French mathematician

b. 1445, Paris

d. 1500

Chuquet took a degree in medicine at Paris, but is best known for the publication of a book on arithmetic in which the radical sign with an index is used for the first time, e.g., $\sqrt[n]{x}$. The title was *Tripartite en la Science des Nombres*.

CIDENAS

Cidenas

Babylonian astronomer

c. 343 B.C.

Cidenas was the head of an astronomical school at Sippra, and was the discoverer of the precession of the equinoxes.

Clairaut, Alexis Claude

French mathematician

b. May 7 (?13), 1713, Paris

d. May 17, 1765, Paris

Something of a child prodigy, Clairaut was elected to the Academy of Sciences before the customary age. In work on the figure of the earth he evolved a new theorem, named after him, connecting the gravity on the surface of a rotating ellipsoid with the compression and centrifugal force at the equator. He also worked on astronomical problems and calculated the date of reappearance of Halley's comet.

Clark, Alvan

American astronomer

b. 1804, Ashfield, Mass.

d. 1887

Clark made the large refractors of the Lick and Pulkovo observatories, and his son, Alvan Graham (1832-97) made the 40 in. lens for the Yerkes refractor, and, while testing an 18½ in. telescope made by the firm, in 1862 discovered the companion to Sirius.

Clark, Josiah Latimer

English engineer

b. Mar. 10, 1822, Great Marlow, Bucks.

d. Oct. 30, 1898, London

Though trained as a chemist, Clark turned to engineering and electrical work, especially cable-laying. He was assistant engineer at the construction of the Menai Straits Bridge and he invented the *double-cap invert* insulator and the *Clark cell*.

Clark, Thomas

Scottish chemist

b. Mar. 31, 1801, Ayr

d. Nov. 27, 1867, Glasgow

Clark was educated at Ayr, and became a lecturer in chemistry at the Mechanics' Institute, Glasgow, and later (1833) professor of chemistry at Aberdeen. He

was an authority on water purification and introduced the use of calcium hydroxide for softening water.

Clark, William Mansfield

American chemist

b. Aug. 17, 1884, Tivoli, N.Y.

Educated at the Johns Hopkins University, Clark became a chemist in the U.S. Department of Agriculture, and after holding other posts went to the Johns Hopkins University as professor of physiological chemistry. His original work on hydrogen-ion concentration and on oxidation reduction equilibria is most important.

Clarke, Alexander Ross

Scottish geodesist

b. Dec. 16, 1828, Sutherlandshire

d. Feb. 11, 1914

After studying at Woolwich, Clarke became an army engineer and was eventually attached to the Ordnance Survey. He was notable for his work on the Principal Triangulation of the British Isles, and he did much to correlate this with similar work in other countries. His book *Geodesy* (1880) was an authoritative work, proposing the Clarke ellipsoids as standards. He worked also on the figure of the earth.

Clarke, Frank Wigglesworth

American geologist

b. 1847, Boston

d. 1931

Educated at Harvard, Clarke became professor of physics at Howard University and at Cincinnati (1874-83), before being appointed chief chemist to the U.S. Geological Survey (1883-1925). He did much work on the re-calculation of atomic weights, and made geochemical calculations on the proportions of shales, sandstones and limestones in sedimentary deposits.

Claude, Georges

French chemist and physicist

b. 1870

A member of the Academy of Sciences since 1924, Claude is noted for his work on gases, e.g., the liquefaction of air, manufacture of oxygen, separation of rare gases in the air and their use in lighting,

etc. He is credited with the idea of the use of electromagnetic wave measurement and neon lighting for signs, and made a considerable fortune from this and other inventions. Another idea of his was to use the inequalities of temperature found in the oceans to produce power, but his plant was not a commercial success. He worked also on the synthesis of ammonia, and discovered the safety of acetylene in an acetone solution.

Clausius, Rudolf Julius Emmanuel
German physicist

b. Feb. 2, 1822, Köslin, Pomerania

d. Aug. 24, 1888, Bonn

Educated at Berlin and Halle, Clausius became professor of physics at the former university in 1850, and later went to Zürich, Würzburg and Bonn. He was one of the founders of thermodynamics and made important researches in molecular physics and electricity. In 1850 he stated the second law of thermodynamics as: heat cannot pass of itself from a colder to a hotter body. He was awarded the Copley medal in 1879. The *Clausius-Clapeyron equation* relates pressure and temperature in working changes of state.

Clayton, John
English scientist

c. 1650

A theologian by education, Clayton was interested in science, and was the first to discover that gas could be distilled from crude coal and stored. He told Boyle of his discovery but neither realised its commercial importance. He is also known for his work on stained glass.

Clément-Desormes, Nicolas
French chemist

b. Dijon

d. 1841

A professor of applied chemistry in Paris, Clément-Desormes is noted for work on the determination of the true nature of carbon monoxide. He also made improvements in the method of manufacturing sulphuric acid, and worked on the direct measurement of specific heats.

Cleve, Per Theodor
Swedish chemist

b. 1840, Stockholm

d. 1905

Educated at Uppsala and Paris, Cleve became professor of chemistry at the former university. He was the discoverer of the elements thulium and holmium in the rare earth erbia; he was interested also in biology, making a study of the plankton in the North Sea.

Clifford, William Kingdon

English mathematician

b. May 4, 1845, Exeter

d. Mar. 3, 1879, Madeira

Educated at London and Cambridge, Clifford became professor of applied mathematics at University College, London. At an early age his health gave way and though temporarily restored by a continental holiday he died soon afterwards. A writer of works on metaphysics in which he developed his conception of consciousness as 'mind-stuff', he also did a great deal to spread non-Euclidean geometry, and his work on the theory of functions was equally valuable. Also may be mentioned his papers on loci, biquaternions and his *Canonical Dissection of a Riemann's Surface*. His early death was a great loss to mathematics.

Clausius. See Lecluse

Coblentz, William Weber

American physicist and astronomer

b. Nov. 20, 1873, North Lima, Ohio

Educated at the Case School of Applied Science and at Cornell University, Coblentz became physicist at the National Bureau of Standards in 1905. He is noted for his work on infra-red, ultra-violet, planetary and stellar radiation for which he has received many honours and awards. His work with a thermo-couple 1/200 inch in diameter to determine surface temperatures on the planets has solved important problems in connection with life on Mars.

Cockcroft, Sir John Douglas

English physicist

b. May 27, 1897

Educated at Manchester and Cambridge,



SIR J. D. COCKCROFT: a photograph taken on his first day at the Harwell Research Establishment.

Cockcroft became professor of physics at the latter university in 1939. In 1932, with Walton, he succeeded in disintegrating lithium by means of proton bombardment. Since 1946 he has been Director of the Atomic Energy Research Establishment of the Ministry of Supply. Previously he was professor of natural philosophy at Cambridge (1939-46), superintendent of Air Defence Research Establishment (1941-44) and director of the Atomic Energy Division of Canada (1944-46). His work on high velocity protons, more efficient disintegrators than alpha-particles, was a significant advance. His papers include reports on his work on high velocity positive ions (1930 and 1935). With Walton he was awarded the Nobel Prize for Physics in 1951.

Cocker, Edward
English mathematician
b. 1631
d. 1675, London

Cocker was the schoolmaster writer of a famous *Arithmetic* which was the first commercial arithmetic in England. It was so successful that 'according to Cocker' has become a byword for accuracy.

Coddington, Henry
English mathematician
b. c. 1800

d. Mar. 3, 1845, Rome
Educated at Cambridge, Coddington is remembered for his suggested lens, named after him, which is really a glass sphere with a deep equatorial groove. This arrangement avoids the indistinctness of the marginal portions caused by spherical aberration. The date of this was 1830, but, in truth, the idea came from Brewster in 1820.

Cohen, Julius Berend
English chemist
b. May 6, 1859, Manchester
d. June 14, 1935

Trained at Manchester, Leeds and Munich, Cohen was professor of chemistry at Leeds up to 1924. He was elected F.R.S. in 1911. He did original work on the laws of aromatic substitution and on optical activity, and was an authority on smoke abatement.

Cohn, Ferdinand Julius
German bacteriologist
b. Jan. 24, 1828, Breslau
d. June 25, 1898, Breslau

Educated at Breslau and Berlin, Cohn became professor of botany at the former university. A pupil of Müller, he is recognised as the father of bacteriology as he was the first to consider it as a separate science. He made important researches in plant pathology, studying fungi which are parasitic on plants and showing that bacteria are plants. He was associated with Koch in his work on anthrax.

Coindet, Jean François
Swiss physician
b. 1774, Geneva
d. 1834, Nice

Educated at Edinburgh, Coindet became a physician in Geneva and was responsible for the introduction of iodine treatment for goitre. Iodine was, of course, the effective constituent of calcined sponge which had been previously used, but this remedy was not altogether satisfactory.



A. H. COMPTON (*r.*) shows his cosmic ray meter to three other Nobel laureates (*l. to r.*), V. F. HESS, W. K. HEISENBERG, C. D. ANDERSON.

Colin, Jean Jacques

French chemist

b. 1784

d. 1865

Professor of chemistry at Dijon, Colin succeeded, while working with Robiquet in 1827, in isolating alizarin and purpurin, two dyes extracted from the madder root. Alizarin has been used since the time of the ancient Egyptians to produce Turkey red.

Colton, Gardner Quincy

American chemist

b. 1814

d. 1898

In 1844 after demonstrating the effect of 'laughing gas' (nitrous oxide), Colton was the first, with Horace Wells, to make use of this gas for the extraction of a tooth. The difficulties connected with its administration, however, prevented it from being used for a long time, but he re-introduced it as a dental anaesthetic in 1869.

Common, Andrew Ainslie

English astronomer

b. Aug. 7, 1841, Newcastle

d. June 2, 1903, Ealing, Middlesex

Trained as a sanitary engineer, Common gained a considerable reputation as an amateur astronomer and was elected F.R.S. in 1885. In 1881 he was the first to apply photography to the study of nebulae.

Compton, Arthur Holly

American physicist

b. 1892, Wooster, Ohio; *d.* 1954

One of the greatest authorities on atomic science, Compton was educated at Wooster and Princeton, and became assistant in physics at the latter university in 1914. A long series of high academic appointments led to the post of chancellor of Washington University, St. Louis (1945). He has taken a leading part in the development of nuclear energy and investigations on cosmic rays, and has represented America in many international scientific congresses. He was awarded the Nobel

COMTE

prize for physics with C. T. R. Wilson in 1927. His original discoveries in physics include the effect of scattering on X-rays (*Compton effect*), the total reflection of X-rays, the polarisation of X-rays, X-ray spectra from ruled gratings, the variation of cosmic rays with latitude and altitude, and the quantity production of plutonium. He is the author of many technical works on X-rays and related topics, and also of works dealing with the relation of science to life.

Comte, Isidore Auguste Marie François Xavier

French philosopher

b. Jan. 19, 1798, Montpellier

d. 1857, Paris

The founder of a scientific philosophy known as the *positive system*, Comte was educated at the École Polytechnique. After teaching here for some time, he was obliged to leave as a result of quarrelling with his superiors and was for some time in financial difficulties. A severe mental breakdown, after which he attempted suicide, interrupted the development of his theories. He carried his belief in his own religion to such limits that he conducted marriage and funeral services as high priest. Nevertheless his philosophical system was a distinct contribution to scientific thought.

Conant, James Bryant

American chemist

b. Mar. 26, 1893, Dorchester, Mass.

Educated at Harvard, Conant became professor of organic chemistry (1927) and then president of the University (1933). He has done much research on free radicals, haemoglobin and chlorophyll, and contributed to the organising of U.S. atomic energy projects during the late war.

Condamine, C. M. de La. See La Condamine

Condorcet, Marie Jean Antoine Nicolas de Caritat, Marquis de

French mathematician and writer

b. Sept. 17, 1743, Ribemont, Picardy

d. Apr. 8, 1794, Bourg-la-Reine

Educated at the Jesuit College at Rheims and in Paris, Condorcet was elected to the Academy of Sciences at an early age through his work on the integral calculus and on the problem of three points. He also gained a Berlin prize for his *Theory of Comets*. He turned to politics and took an active part in the revolution as a Girondist. He was president of the Legislative Assembly in 1792. In common with others of the earlier leaders he was denounced and eventually imprisoned by later leaders. He died, probably by poison, on his first night in prison.

Congreve, Sir William, Bart.

English inventor

b. May 20, 1772

d. May 16, 1828, Toulouse

Educated at Cambridge, Congreve first studied law but eventually devoted most of his time to invention. His most famous achievement was a rocket used for warfare and he followed this with a gun-recoil mounting. Among other productions were a 'perpetual' motion machine, a steam-engine, a colour-printing process and a rocket for killing whales. He was elected F.R.S. in 1811, and was a Member of Parliament.

Cooke, Josiah Parsons

American chemist

b. 1827, Boston, Mass.

d. 1894

Educated at Harvard, Cooke became professor of chemistry and mineralogy there (1850-94). He is noted for his determination of the atomic weight of antimony, and for his theory of atomic weights which was a forecast of the periodic system.

Cooper, Sir Astley Paston

English surgeon

b. Aug. 23, 1768, Brooke, Norfolk

d. Feb. 12, 1841, London

After studying at St. Thomas's Hospital and Edinburgh, Cooper became lecturer on anatomy and finally went to Guy's as surgeon. He later became professor of comparative anatomy to the Royal College of Surgeons (1813), and surgeon to the King (1828). His fame rests upon his

performance in 1817 of an operation for aneurism which consisted of tying the abdominal aorta, an almost incredible feat in view of the fact that antiseptic surgery was not then known. See B. B. Cooper, *Life of Sir Astley Cooper* (1843).

Copernicus, Nicolaus

Polish astronomer

b. Feb. 19, 1473, Thorn, Poland

d. May 24, 1543, Frauenburg

A Pole of German descent, after studying medicine and theology at Cracow Copernicus became a canon of the cathedral at Frauenburg. He taught mathematics and astronomy at Rome, and studied medicine at Padua before returning to Prussia. He is famous as the discoverer of the fundamental truth that the sun is the centre of the solar system, stating as a corollary the earth's rotation, and he was aware of the immense distance of the stars. His theories enabled him to explain the seasons and the precession of the equinoxes, but he still considered the orbits of the planets to be circles and clung to the use of epicycles. His work, *De Orbium Coelestium Revolutionibus*, completed in 1530, but not published until 1543 at Nürnberg, was banned until 1758 by the Roman Catholic Church. See G. J. Rheticus.

Cori, Carl Ferdinand

American biochemist

b. Dec. 5, 1896, Prague

Educated at Trieste and Prague, Cori became an American citizen in 1922 and eventually became professor of pharmacology and biochemistry at Washington. An authority on carbohydrate metabolism and enzymes of animal tissues, he and his wife, Gerty T. Cori, were awarded the Nobel prize for medicine in 1947, jointly with Houssay.

Coster, Dirk

Dutch physicist

b. Oct. 5, 1889, Amsterdam

In 1923 while working in Copenhagen at the Bohr Institute of Theoretical Physics with von Hevesy, Coster discovered the element *hafnium*. He became professor of physics and meteorology at Groningen.

Cottrell, Frederick Gardner

American chemist

b. Jan. 10, 1877, Oakland, California

Educated in California and Leipzig, Cottrell became director of the Bureau of Mines; he was president of the Research Associates, Inc. (1935). His researches have been mainly in the direction of nitrogen fixation, the liquefaction of gases and the recovery of helium. He has invented apparatus (*Cottrell precipitator*) for the precipitation of particles from gases.

Coulomb, Charles Augustin de

French physicist

b. June 14, 1736, Angoulême, Charente

d. Aug. 23, 1806, Paris

After serving as a military engineer in the West Indies Coulomb returned to France and retired at the time of the Revolution, taking to scientific research. He is famous for his work in electricity and magnetism, and for his invention (independently of Michell, 1750) of the torsion balance. He proved that the force exerted between two charged bodies depends on the charges



NICOLAUS COPERNICUS

COUPER

and the distance between them, which is Newton's law of inverse squares applied to electricity (*Coulomb's law*). The practical unit of quantity in measuring electricity is named after him.

Couper, Archibald Scott

Scottish chemist

b. 1831, nr. Glasgow

d. 1892

After receiving a classical education at Glasgow and Edinburgh, Couper later turned to chemistry and studied at Berlin and Edinburgh. He evolved a theory of molecular structure which was practically the same as Kekulé's, but delay in publication lost him priority by one month.

Courtois, Bernard

French chemist

b. 1777, Dijon

d. 1838, Paris

After studying chemistry at the École Polytechnique and serving as pharmacist in a military hospital, Courtois returned to his father's business of soap manufacturing. He did not prosper, however, and died in poverty despite a government award for his discovery of iodine. It was in 1811 that he discovered this new substance in the liquor from the lixiviation of kelp. This was presented by Ampère in 1813 to Davy, who pronounced it an element and named it from Gay-Lussac's name for it, *iode*, on account of the violet colour of its vapour. Gay-Lussac published his results at the same time and there was some argument as to who should have the honour of the discovery.

Cowell, Philip Herbert

English astronomer

b. Aug. 7, 1870, Alipore, Calcutta

d. June 6, 1949, Aldeburgh, Suffolk

After a period as Chief Assistant at Greenwich, Cowell was superintendent of the Nautical Almanac Office from 1910 to 1930. He did research work on the retardation of the earth's rotation period, from which it has been calculated that the day is lengthening by something of the order of 0.01 seconds per thousand years.

Crawford, Adair

Irish physician

b. 1748, Antrim

d. July, 1795, Lymington, Hants.

Educated at Glasgow, Crawford became a physician at St. Thomas's Hospital and professor of chemistry at Woolwich. He was the author of a treatise on animal heat and is remembered as the first to recognise the presence of a new substance in a mineral from Strontian, Argyllshire. This was eventually isolated by Davy and named *strontium*.

Crompton, Samuel

English inventor

b. Dec. 3, 1753, Firwood, nr. Bolton

d. June 26, 1827, Bolton

Beginning as a mill-hand, Crompton was inspired to improve the methods in use in the mills and this led to his famous invention of the 'mule', a cotton spinning machine which combined Hargreaves' spinning jenny and Arkwright's roller-frame. In common with many other inventors he showed a lack of business acumen, and despite much help was a consistent financial failure, having to rely in later life on a small annuity bought by his friends.

Cronstedt, Axel Fredrik, Baron

Swedish metallurgist

b. 1722, Södermanland

d. 1765, Säter, Stockholm

Trained in mathematics and the physical sciences, Cronstedt became metallurgist in the Bureau of Mines, and in 1751 discovered the metal nickel, noticing its slight magnetic properties. He also discovered a zeolite (a water-softening silicate) and made a useful chemical classification of minerals which is widely used.

Crookes, Sir William

English chemist and physicist

b. June 17, 1832, London

d. Apr. 4, 1919, London

After studying at the Royal College of Chemistry, London, Crookes became professor of chemistry at Chester College, and was elected F.R.S. in 1863 and president of the British Association in 1898.

The inventor of the Crookes vacuum tube to demonstrate electrical discharges in high vacua, he was the first to suggest the true nature of cathode rays as fast-moving negatively-charged particles—an idea not well received by other physicists at the time. The Crookes dark space is the dark layer which appears round the cathode in electric discharges at low pressure. In 1875 he invented a radiometer consisting of four platinum vanes, blackened on one side, mounted on a light framework and pivoted on a fine needle in a vacuum. This rotates under the radiation pressure of light. He discovered the element thallium from an examination of the Fraunhofer lines in the spectrum, and in 1900 he separated uranium into two parts, naming the new one uranium-X. He invented the spinthariscopes in 1903 to demonstrate the emission of particles by radium; the ejected α -particles bombard a layer of zinc sulphide and the fluorescent spots produced are viewed through a lens. He was a great authority on sanitation, and he drew attention to the need for artificial sources of nitrogen for fertilisers. Like some other scientists he believed in spiritualism, and thought that telepathy was a manifestation of waves between brains.

Cross, Charles Frederick

English chemist

b. 1855, Brentford, Middlesex

d. Apr. 15, 1935

Educated at London, Zürich and Manchester, Cross became an F.R.S. in 1917, and with Bevan invented the modern method of producing artificial silk.

Crum Brown. See **Brown, A. Crum**

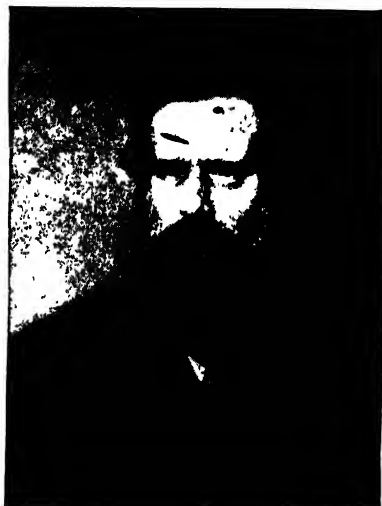
Cugnot, Nicolas Joseph

French engineer

b. 1725

d. 1804

One of the earliest experimenters in mechanical transport, Cugnot invented about the year 1770 a three-wheeled steam-driven carriage. Its speed was about two and a half miles per hour.



SIR WILLIAM CROOKES

Cullen, William

Scottish physician

b. Apr. 15, 1710, Hamilton, Lanark

d. Feb. 5, 1790, Kirknewton, Midlothian

Educated at Glasgow, Cullen became professor of medicine there in 1751 and of chemistry at Edinburgh in 1756. He was the first to notice, with Dr. Darwin, that heat is produced during the compression of a gas. While lecturing at Edinburgh he was the first to use his native tongue instead of Latin.

Curie, Marja Skłodowska

Polish physicist and chemist

b. Nov. 7, 1867, Warsaw

d. July 4, 1934

The assistant and subsequently wife of Pierre Curie, Mme Curie was educated in Paris under Poincaré and Lippmann, and became famous through her discovery, with her husband, of radium. In 1898 in her celebrated experiments on uranium minerals, she first separated polonium. The quantity of radon in radioactive equilibrium with a gramme of radium was named a curie, and this was later taken as equivalent to the emission of 3.7×10^{10}

CURIE



MME MARJA CURIE: the family has won five Nobel awards in two generations.

alpha-particles per sec. Among other honours she gained the Nobel prize for chemistry in 1911 after having shared the Nobel prize for physics in 1903 with her husband and Becquerel. She is the only person to have received such a prize twice.

Curie, Pierre

French physicist and chemist

b. May 15, 1859, Paris

d. Apr. 19, 1906, Paris

Educated at Paris, Curie became a professor at the Sorbonne and did research on piezo-electricity and the growth of crystals, as well as being co-discoverer of radium with his wife. He discovered that all substances change their magnetic properties at a certain temperature, now known as the 'Curie point'. He was a Nobel prize winner in 1903, and was killed in a street accident. (See also Joliot-Curie.)

Curtius, Theodor

German organic chemist

b. 1857

d. 1928

Professor of chemistry at Heidelberg, Curtius is noted for his contributions to synthetic chemistry and in particular for his discovery of hydrazine in 1887, and many other organic compounds.

Cushing, Harvey

American neurologist

b. Apr. 8, 1869; d. Oct. 7, 1939

Educated at Yale and Harvard, Cushing studied in Europe before returning to the Johns Hopkins University and later to Harvard as professor of surgery. He is famous for his brain operations (especially with local anaesthesia) and for his work on the pituitary gland. He is author of several books, including *The Pituitary Body and its Disorders* (1912); and his *Life of Sir William Osler* (1925) gained the Pulitzer prize.

Cuvier, Georges Léopold Chrétien

Frédéric Dagobert, Baron

French naturalist

b. Aug. 23, 1769, Montbéliard.

d. May 13, 1832, Paris

After studying at Stuttgart, Cuvier devoted his time to zoology and became professor of natural history at the Collège de France in 1799. He became known for his natural classification of the worms and later for his important complete classification of the animal kingdom as well as for his work on comparative anatomy. He took a particular interest in fossil remains and was the first to identify and name the pterodactyl. Through his work in this field, palaeontology became a separate science. Among his works are *Tableau Élémentaire de l'Histoire Naturelle des Animaux* (1798), *Leçons d'Anatomie Comparée* (1800-05) and *Histoire Naturelle des Poissons*.

1811 he obtained urea synthetically by the action of ammonia gas on carbonyl chloride (which he called phosgene). He was unaware that urea was formed in the reaction.

Deacon, Henry
English chemist
b. 1822, London
d. 1877

Trained as an engineer, Deacon turned to chemistry as a result of acquaintance with Faraday. He became engaged in the development of the Lancashire alkali trade, and invented a well-known process, named after him, for the manufacture of chlorine. This consisted of oxidation of hydrochloric acid using atmospheric air and a catalyst (cupric chloride).

de Broglie, Maurice, Duc
French physicist
b. Apr. 27, 1875, Paris

A member of an ancient noble French family, de Broglie was educated at the École Navale and served as a naval officer before becoming a professor of physics. A foreign member of the Royal Society, he is noted for his work on atomic physics and X-rays (see below).

de Broglie, Louis Victor
French physicist
b. Aug. 19, 1892, Dieppe

A brother of Maurice (see above), educated in Paris, de Broglie became professor of physics there in 1932. He is famous for his researches in nuclear physics, in which he linked wave and corpuscular theory together for the first time. He was awarded the Nobel prize for physics in 1929 for this work.

Debye, Peter Joseph Wilhelm
Dutch-American physicist
b. Mar. 24, 1884, Maastricht
Educated at Munich, Debye became lecturer there, and after holding professorships successively at Zürich, Utrecht, Göttingen and Leipzig, he was appointed to the Kaiser Wilhelm Institute for Physics in Berlin in 1935. He gained the Nobel prize for chemistry in 1936, and went in

1940 to the U.S.A., where he became professor at Cornell. His research on polar molecules, dipole moment and molecular structure is particularly famous. He was a pioneer in X-ray powder photography, and with Hückel worked on the problems of solutions of salts.

De Forest, Lee
American inventor

b. Aug. 26, 1873, Council Bluffs, Ia.

Educated at Yale and at the Armour Institute of Technology, Chicago, De Forest was employed in the Western Electric Company and later founded his own laboratories in California. The 'father of radio', he is famous for his inventions in connection with wireless and was the first to use the alternating current generator and transmitter. He introduced the grid into the wireless valve and invented the audion amplifier and the four electrode valve. Since 1921 he has also done much work on the development of 'talking pictures' and television, and his inventions and improvements in these branches of applied science are very numerous.

Delambre, Jean Baptiste Joseph
French astronomer
b. Sept. 19, 1749, Amiens
d. Aug. 19, 1822, Paris

Training under Lalande, Delambre became famous for his astronomical calculations on Uranus, and later served on the Bureau de Longitudes. In 1807 he became professor of astronomy at the Collège de France. Among other works he wrote three histories dealing with astronomy, and discovered *Delambre's analogies* in spherical trigonometry.

de la Rue, Warren
English scientist
b. Jan. 18, 1815, Guernsey
d. Apr. 19, 1889, London

Educated at Paris and in London, de la Rue did work in chemistry, physics and astronomy. With H. Müller he invented the silver chloride battery, and he performed many experiments on the discharge of electricity through gases. He was an

DELÉPINE

F.R.S. and a president of the Chemical Society, being one of the original members of the latter. In astronomy he invented the photo-heliograph for studying the sun's surface, and his photographs of the solar eclipse of 1860 settled the question as to the origin of the prominences.

Delépine, Marcel

French chemist

b. 1871, St. Martin-le-Gaillard

After studying in Paris, Delépine became professor of organic chemistry in the Collège de France in 1930. He has conducted a wide series of researches on rhodium, organic sulphur compounds, terpenes and pyridines.

Delisle, Joseph Nicolas

French astronomer and mathematician

b. Apr. 4, 1688, Paris

d. Sept. 12, 1768, Paris

Distinguished in geography, astronomy and mathematics, Delisle noticed in 1715 the diffraction spot in the centre of the shadow of a small circular object. The significance of this was not understood at the time. He explained the corona of the sun as being due to refraction, and devised methods of observing the transits of Venus and Mercury.

Del Rio, Andrés Manuel

Spanish mineralogist

b. 1764, Madrid

d. 1849, Mexico

Educated at San Isidro in theology, Del Rio later studied mining in Freiberg and chemistry in Paris. Owing to his association with Lavoisier he was forced to disguise himself in order to escape to England from the revolutionaries. In 1793 he went to Mexico as professor of mineralogy at the School of Mines, and in 1801 discovered a new metal, vanadium. He was later led to think that his new element, which he had named erythronium, was the recently discovered chromium on account of the similarity of their chemical properties, but this was afterwards shown to be incorrect.

Deluc, Jean André

Swiss geologist

b. Feb. 8, 1727, Geneva

d. Nov. 7, 1817, Windsor, Berks.

From business and politics Deluc turned to scientific study and travel, and settling in England in 1773 he became a Fellow of the Royal Society. Like Black he was interested in latent heat and noted the phenomena connected with melting ice. He also found the temperature of maximum density of water to be 4°C. , and he was the originator of the theory concerning the quantity of aqueous vapour in a given space and its independence of the air density. He constructed a hygrometer of new pattern, invented a dry pile, and gave the first accurate account of the barometric determination of height. He endeavoured to reconcile science with *Genesis*.

Demarçay, Eugène Anatole

French chemist

b. 1852, Paris

d. 1904, Paris

Educated at the École Polytechnique, Demarçay discovered in 1901 a new rare earth which he called europia, the oxide of europium. He discovered *europium* spectroscopically in 1896, and also gave spectroscopic proof of the discovery of radium.

Demoivre, Abraham

English mathematician

b. May 26, 1667, Vitry, Champagne

d. Nov. 27, 1754, London

Of French extraction, Demoivre became famous as a mathematician and was elected F.R.S. in 1697. He was chosen to decide the Newton-Leibniz controversy over the invention of the differential calculus. His contributions to trigonometry are two well-known theorems concerning expansions of trigonometrical functions.

De Morgan, Augustus

English mathematician

b. 1806, Madura, India

d. Mar. 18, 1871, London

Educated at Cambridge, De Morgan became professor of mathematics at London after difficulties over his religious

beliefs had prevented his advancement at Cambridge. Most famous perhaps in the field of logic, he nevertheless contributed largely towards the progress of mathematics by his text-books and treatises on arithmetic, algebra and trigonometry; a theorem still bears his name. A popular work was the *Budget of Paradoxes* (1872).

Denning, William Frederick

English astronomer

b. Nov. 25, 1848, nr. Radstock, Somerset

d. June 9, 1931

An amateur astronomer, Denning became a Fellow of the Astronomical Society in 1877 and is noted for his discovery of five comets and some nebulae. Apart from work on the planets he is best remembered for his study of meteors, and his discovery of the connection between certain showers and comets. He discovered a new star in Cygnus on Aug. 20, 1920. His measurements of the heights and velocities of meteorites have enabled other scientists (for instance, Cherwell) to make important deductions about the upper atmosphere.

Desargues, Gérard

French mathematician

b. 1593, Lyons

d. 1662, Lyons

As an engineer, Desargues took part in the siege of La Rochelle. He lectured on mathematics in Paris, and is one of the founders of modern geometry, producing as he did the theory of involution and transversals. His book *Brouillon Project* (1639) on conics, covers most of his work.

Descartes, René

French philosopher and mathematician

b. Mar. 31, 1596, La Haye, Touraine

d. Feb. 11, 1650, Stockholm

Born of a good family, Descartes entered the army at first, as was usual for men of his social standing, but was attracted to mathematics by the solving of a geometrical problem which had been advertised as a challenge to all mathematicians. He is famous for his invention of co-ordinate (Cartesian) geometry, and even more famous for his system of philosophy, being regarded as the father of modern



RENÉ DESCARTES invented co-ordinate geometry while lying in his bed in the mornings.

philosophy. His *Discours de la Méthode* (1637) advanced the desirability of mathematical proof in metaphysics, but this did not prevent him from holding narrow and utilitarian views about learning and art, both of which he despised unless something tangible could be extracted from them. He died unmarried, one daughter having died previously. He wrote the first text-book on physiology but noting the reaction of the church to Galileo's works he withheld its publication. It was published twelve years after his death.

Deshayes, Gérard Paul

French geologist

b. May 13, 1795, Nancy

d. June 9, 1875, Boran, Oise

After studying medicine in Strasbourg and Paris, Deshayes devoted himself to zoology and conchology and became professor in Paris in the latter subject. He studied the fossils of the Paris basin and amassed a collection of forty thousand specimens.

Deville, Henri Étienne Ste-Claire

French chemist

b. Mar. 11, 1818, West Indies

d. July 1, 1881, Paris

de VRIES

Educated at Paris in chemistry under Thenard, Deville became professor of chemistry there in 1859. He worked on the technical production of metals and developed high temperature technique, being the first to prepare pure aluminium. In 1841 he discovered toluene and, in 1849, anhydrous nitrogen pentoxide. He investigated thermal dissociation and with Debray worked platinum, using the oxy-hydrogen blowpipe.

de Vries, Hugo

Dutch botanist

b. Feb. 16, 1848, Haarlem

d. May 21, 1935, Lunteren

Educated at Leyden, Heidelberg and Würzburg, de Vries became a professor at Amsterdam in 1878. He introduced the experimental study of evolution and discovered mutations in cultures of *Oenothera*. The results were published in *Die Mutationstheorie* (1900 and 1903). This alternative to natural selection has proved to be of the highest importance in the theory of evolution. He has also done pioneer work on osmosis, and was one of the first to appreciate the importance of Mendel's work.



SIR JAMES DEWAR

Dewar, Sir James

Scottish chemist

b. Sept. 20, 1842, Kincardine

d. Mar. 27, 1923, London

Educated at Edinburgh and Ghent, Dewar became professor of experimental philosophy at Cambridge, and professor of chemistry at the Royal Institution, London. He was an F.R.S. and won the Rumford medal for his work on the properties of matter at low temperatures. He investigated the low temperature magnetisation of liquid oxygen and ozone, and in 1898 was the first to liquefy hydrogen, measuring its refractive index, and to solidify it in 1899. He was the inventor of the vacuum flask (Dewar flask), and his experiments on phosphorescence showed that many common substances, e.g., feathers and eggshell, are phosphorescent at the temperature of liquid air. In 1910 he made a direct measurement of the rate of production of helium from a pure radium salt, his result being 1.14×10^{18} atoms per year. With Abel he discovered cordite.

Diderot, Denis

French philosopher

b. Oct. 5, 1713, Langres, Champagne

d. July 30, 1784, Paris

Educated in a Jesuit school and at Paris, Diderot taught mathematics. He served a prison sentence for heretical writings in his early life and after unsuccessful play-writing he began, with d'Alembert and others, the translation of Ephraim Chambers' *Cyclopaedia*. This they expanded and developed into a fine summary of the scientific knowledge of the age, but the continued opposition of the authorities caused his collaborators, who included Voltaire, Rousseau, Buffon and Montesquieu, to withdraw, and though he finished the work himself after twenty years' toil, it never reached the public in the form in which it was written. Nevertheless the thirty-four volumes of the *Encyclopédie* (1751-77) were a considerable stimulus to the age. Diderot was a prolific writer of plays, fiction, letters and criticism and an ardent adherent of the advanced *philosophes*.

Dieffenbach, Johann Friedrich

German surgeon

b. Feb. 1, 1794, Königsberg

d. Nov. 11, 1847, Berlin

Educated at Bonn and Paris, Dieffenbach worked at Berlin and acquired considerable fame as a plastic surgeon. His methods of forming new noses, eyelids and lips were a great advance on previous work and he had considerable success in the cure of squinting and stammering.

Diesel, Rudolph

German inventor

b. Mar. 18, 1858, Paris

d. Sept. 29-30, 1913, at sea

Educated in England and at Munich under Linde, Diesel studied heat engines and eventually invented the motor named after him. The first successful example was built in 1897. When on his way to England in the *Dresden* to consult with the Admiralty about his invention he disappeared and was apparently drowned in the Channel.

Diophantus

Mathematician

c. 3-4th century A.D.

The first writer on algebra, Diophantus is sometimes called the father of the subject, though it was so named by the Arabs. He lived at Alexandria but his nationality is not known for certain. He was 84 when he died. Six books of his *Arithmetica* exist. Indeterminate equations with rational coefficients for which a rational solution is required are called *Diophantine equations*.

Dioscorides, Pedanius

Greek physician

b. c. 50 A.D., Cilicia

A military surgeon in Nero's army, Dioscorides was one of the earliest botanists. His book, *De Materia Medica*, describes about six hundred plants and was much used up to the Middle Ages. His reference to the use of mandrake to put patients to sleep before operation is probably the first mention of surgical anaesthesia.

Dirac, Paul Adrien Maurice

English physicist

b. Aug. 8, 1902, Bristol

Educated at Cambridge, Dirac became professor of mathematics there in 1932, having been elected F.R.S. in 1930. In that year he predicted from theory the existence of the positron, which Blackett and Anderson discovered in 1932. In 1933 he was awarded the Nobel prize for physics with Schrödinger for his work on quantum mechanics, and in 1930 he published his *Principles of Quantum Mechanics*. He advanced the theory of the spinning electron.

Ditton, Humphry

English mathematician

b. May 29, 1675, Salisbury

d. Oct. 15, 1715, London

A mathematics master at Christ's Hospital, Ditton wrote several text-books on mathematics and was the first to attempt a mathematical explanation of capillarity. He also invented a method of determining longitude.

Dixon, Harold Bailly

English chemist

b. Aug. 11, 1852, London

d. Sept. 18, 1930

Educated at Oxford in classics as well as science, Dixon went to Manchester as professor and did notable work on the explosion of gases. His discoveries were particularly valuable in the mining industry, and he was a world authority on combustion research. His work included research on the influence of water on chemical change; for example, he discovered that a dry mixture of oxygen and carbon monoxide could not be exploded electrically.

Döbereiner, Johann Wolfgang

German chemist

b. Dec. 15, 1780, Hof, Bayreuth

d. Mar. 24, 1849, Jena

After becoming professor of chemistry at Jena in 1810, in 1829 Döbereiner brought forward his famous theory of triads—the first evidence of periodicity in the elements. He also conducted researches on the

DOISY

catalytic action of platinum in which connection he invented an instantaneous lighting lamp, named after him.

Doisy, Edward Adelbert

American biochemist

b. Nov. 13, 1893, Hume, Ill.

Educated at Illinois, Harvard and Washington, Doisy held many academic posts in American universities before becoming director of the department of biochemistry at St. Mary's Hospital, St. Louis, in 1924. Noted for his work on sex hormones, including the isolation of theelin (oestrone) in 1929, of vitamin K₂ (1939) and the synthesis of K₁ (1939) he was awarded the Nobel prize for chemistry in 1943 (with Dam).

Dollond, John

English optician

b. June 10, 1706, Spitalfields, London

d. Nov. 30, 1761, London

Brought up as a silk weaver, his parents being Huguenot refugees from France, Dollond joined his eldest son in his trade of optician. The inventor of achromatic lenses in 1758, independently of Chester Moor Hall, he showed that two kinds of glass (crown and flint) could be used to make colour-free object glasses, and he was awarded the Copley medal in 1758 for this invention, and in 1761 became an F.R.S. Another invention was a heliometer.

Domagk, Gerhard

German biochemist

b. Oct. 30, 1895, Brandenburg

From the universities of Greifswald and Münster, Domagk went as director to the Elberfeld research institute in 1927. He discovered the properties of *prontosil*, an orange-red dye compound containing sulphanilamide, patented by Mietzsch and Klaren, but refused the Nobel prize for physiology and medicine in 1939 on instruction from the German government. Three years' experimenting on mice with this drug showed 100 per cent. cure for blood-poisoning and ushered in a new age in chemo-therapy. Sulphanilamide

had actually been isolated before by P. Gelmo (1908), a student at Vienna, who had not realised its possibilities. It is now the prototype of a whole family of drugs.

Donati, Giovanni Battista

Italian astronomer

b. Dec. 16, 1826, Pisa

d. Sept. 20, 1873, Florence

Educated at Pisa, Donati was noted for his researches on stellar spectra, in which connection he constructed a spectroscope containing twenty-five prisms and was the first to observe the spectrum of a comet. Donati discovered in 1858 the comet named after him, and five others. He was responsible for the erection of the observatory at Florence, becoming its director in 1864. He died of cholera.

Donnan, Frederick George

Irish chemist

b. Sept 6, 1870, Holywood, Co. Down

Educated at Belfast, Leipzig, Berlin and London, Donnan went to Liverpool in 1904 as professor of physical chemistry and then to London as professor of chemistry at University College (1913-37). He was elected F.R.S. in 1920. He has done much research in chemical kinetics and produced a theory of membrane equilibria, named after him, which is of importance in the study of proteins and other biochemical colloids.

Doppler, Christian Johann

Austrian mathematician and physicist

b. Nov. 29, 1803, Salzburg

d. Mar. 17, 1853, Venice

Professor of mathematics at Prague, and of experimental physics at Vienna, Doppler discovered the famous principle, named after him, which states that for moving sources of light the frequency observed is greater or less than the actual as the body approaches or recedes from the observer. Doppler's shift is an application of this to the spectra of luminous bodies and was applied to stars by Fizeau. This very important principle enables us to measure the absolute speeds of stars and galactic systems.

Dorn, Friedrich Ernst

German chemist

b. 1848, Guttstadt, E. Prussia

d. June 13, 1916, Halle

Educated at Königsberg, Dorn taught physics at Darmstadt and Halle.* In 1900 he discovered the formation of an emanation from radium, for some time known as niton, but now named radon, or simply radium emanation.

Douglass, Andrew Ellicott

American astronomer

b. July 5, 1867, Windsor, Vermont

Educated at Connecticut, Douglass was assistant to Lowell at the Flagstaff Observatory, becoming professor of physics and astronomy at Arizona and then director of the Steward Observatory. He investigated the history of the sun through an examination of the annual rings of the pines and sequoias of Arizona, and was able to estimate the time of the sun-spot cycle as largely unchanged in the period covered.

Draper, John William

American scientist

b. May 5, 1811, St. Helens, Lancs.

d. Jan. 4, 1882, Hastings, N.Y.

Educated in London and later in the University of Pennsylvania, Draper became professor of chemistry in the New York University and professor of medicine later. Famous for his researches in photochemistry, he was the first to take a human portrait by light, having improved on Daguerre's process. (See also below.)

Draper, Henry

American scientist

b. 1837, Prince Edward County, Pa.

d. Nov. 20, 1882, New York

The son of John William (see above), he was educated in New York as a doctor, becoming professor of natural science there in 1860, and for a short time professor of chemistry. He is remembered for his spectroscopic work, e.g., his production of ruled metal gratings, and proof of oxygen in the sun. The Draper catalogue of spectroscopic types is a memorial to his work.

Driesch, Hans Adolf Eduard

German biologist

b. Oct. 28, 1867, Kreiznach, Prussia

d. Apr., 1941, Leipzig

After studying at Homburg, Freiburg, Munich and Jena, Driesch eventually became professor of philosophy at Heidelberg, and went from there to Cologne, and in 1921, to Leipzig. He conducted some remarkable experiments with the eggs of a sea-urchin (1891). He split the segmented egg into parts, in some cases as small as 1/32 of the original, and obtained complete but of course small embryos. This and other work laid the foundation of the modern biological theory of developmental mechanics. He wrote *Analytische Theorie der Organischen Entwicklung* (1899).

Drude, Paul Karl Ludwig

German physicist

b. July 12, 1863, Brunswick

d. July 5, 1906, Berlin

After study at Göttingen, Freiburg and Berlin, Drude became professor of physics at Leipzig in 1894, at Giessen in 1900 and finally at Berlin. He was noted for his application of Maxwell's electromagnetic theory to the problems of light, and for his work on refraction. He measured the refractive index of metallic sodium (0.12), the smallest known. Circumstances led to his suicide at a comparatively early age.

Dubos, René Jules

French-American bacteriologist

b. 1901

Trained in Paris, Dubos became an American citizen in 1938 having joined the Rockefeller Institute for Medical Research in 1927, becoming a member in 1941. He established his reputation by his work on internal medicine and by his discovery of *tyrothricin*, an antibiotic isolated from *Bacillus brevis*, a rod-like cell very abundant in soil.

Duchenne, Guillaume Benjamin Amand

French physician

b. Sept. 17, 1806, Boulogne

d. Sept. 17, 1875, Paris

Educated at Douai and Paris in medicine,

DUDELL

Duchenne practised as a physician at Boulogne and later at Paris. He experimented in electro-physiology, being the founder of electro-therapeutics. His research on muscles was outstanding and he was the first to describe locomotor ataxia, progressive muscular atrophy and other nervous complaints. He published among many other works *L'Électrisation localisée* (1855) and *Physiologie des Mouvements* (1867), showing the group nature of muscles.

Duddell, William du Bois

English engineer

b. 1872, London

d. Nov. 4, 1917

Educated at Cannes, Duddell became an F.R.S. and did much work on radio-telegraphy. In 1897 he invented a much improved version of the oscillograph, originally invented by Blondel, to convert sound waves into electromagnetic impulses.

Du Fay, Charles François de Cisternay

French chemist

b. Sept. 14, 1698, Paris

d. July 16, 1739, Paris

The superintendent of gardens to the king of France, Du Fay was an early worker on a variety of problems in physics and chemistry. He discovered the two kinds of electricity, positive and negative, and the repulsion that exists between them. He also investigated phosphorescence and double refraction.

Dufrénoy, Ours Pierre Armand Petit

French geologist

b. 1792

d. 1857

A director of the school of mines, Dufrénoy was associated with Élie de Beaumont in the production of a geological map of France (1841). He was an expert on mineralogy, and introduced a new system of classification based on crystallography.

Duhamel du Monceau, Henri Louis

French chemist and botanist

b. 1700, Paris

d. Aug. 23, 1782, Paris

Trained in Paris under Jussieu, Duhamel

was interested in all matters connected with agriculture, being an expert on plant nutrition. In 1736 he was the first to distinguish between potash and soda.

Dulong, Pierre Louis

French chemist

b. Feb. 12, 1785, Rouen

d. July 18, 1838, Paris

Trained as a doctor, Dulong became professor of chemistry and later of physics in Paris. He discovered nitrogen trichloride, a violent explosive, in 1813. Working on the refractive indices and specific heats of gases with Petit, he put forward the law of the constancy of atomic heats (1819). In 1815 he suggested that acids were compounds of hydrogen which could be replaced by a metal, a theory similar to that of Davy, and he evolved a formula, named after him, for the heat value of fuels.

Dumas, Jean Baptiste André

French chemist

b. July 15, 1800, Alais, Gard

d. Apr. 11, 1884, Cannes

After studying chemistry at Geneva, Dumas became professor of chemistry at Paris (1832-68). He conducted important researches on organic compounds, e.g., in 1834 with Peligot he identified methyl alcohol and he isolated anthracene from coal tar in 1831. Nevertheless he considered organic and inorganic chemistry as two separate chemistries. He did much research on the composition of water and on vapour density. He made many accurate determinations of atomic weight. In later life he abandoned science for politics, and became Minister of Education.

Dunér, Nils Christofer

Swedish astronomer

b. May 21 1839, Billeberga, Malmöhus

d. Nov. 10, 1914, Stockholm

Educated at Lund, Dunér turned from geography to astronomy in 1864 and became professor of astronomy at Uppsala and director of the observatory (1888-1909). He was an expert on stellar spectroscopy and showed spectroscopically (in 1891) that different regions of the sun rotate at different speeds. He studied also variable and double stars.

Dunning, John Ray

American physicist

b. Sept. 24, 1907, Shelby, Nebraska

Educated at Nebraska and Columbia Universities, Dunning became professor of physics at Columbia in 1938. In 1940, with Nier, Booth and Grosse, he obtained experimental verification of uranium 235 fission by slow neutrons. This prepared the way for the atomic bomb.

Dutrochet, René Joachim Henri

French physiologist

b. Nov. 14, 1776, Poitou

d. Feb. 4, 1847, Paris

Trained in medicine at Paris, Dutrochet became physician to Joseph Buonaparte of Spain. He was the first to study the phenomenon known as osmosis, and it was he who thus named it in *Nouvelles Recherches sur l'endosmose et l'exosmose* (1828).

Dyson, Sir Frank Watson

English astronomer

b. Jan. 8, 1868, Ashby-de-la-Zouch, Leicester

d. May 25, 1939, at sea-

Educated at Cambridge, Dyson became chief assistant at Greenwich Observatory and then Astronomer Royal of Scotland in 1905. He returned to England in 1910 to the corresponding post at Greenwich. He was elected F.R.S. in 1901. His most noted work was on the distribution and movements of stars, and on the structure of the universe. Under his direction radio time-signals were first broadcast (from Rugby), and the six-pip signal of the B.B.C. was adopted in 1924, providing the first accurate and convenient time-check. He supervised the removal to Abinger in 1923, and introduced the study of stellar parallaxes.

E

Ebbinghaus, Hermann

German psychologist

b. 1850

d. 1909

Noted for his researches on memory, Ebbinghaus conducted a long series of experiments on memorising nonsense syllables with a view to investigating higher mental processes. His results, published in 1885, stimulated further research though subjected to criticism from other authorities.

Eddington, Sir Arthur Stanley

English astronomer

b. Dec. 28, 1882, Kendal

d. Nov. 22, 1944

Educated in a Quaker school and at Manchester and Cambridge, Eddington went to Cambridge as professor of astronomy and director of the observatory, after holding a post at Greenwich. He was elected F.R.S. in 1914. He was



SIR ARTHUR EDDINGTON lecturing on Time and Entropy at Bedford College.

famous for his work on star streams and also on the internal constitution of the stars. He calculated the life of the sun past and future, as fifteen thousand million years, and interpreted the theory of relativity. His works include *Stellar Movement and the Structure of the Universe* (1914), *Space, Time and Gravitation* (1920) and *Stars and Atoms* (1927). *A Generalisation of Weyl's Theory of the Electromagnetic and Gravitational Fields* (1921) was the result of his own work on the theory.

Edgerton, Harold Eugene

American electrical engineer

b. Apr. 6, 1903, Freemont, Neb.

Educated at Nebraska and the Massachusetts Institute of Technology, Edgerton became professor of electrical engineering at the latter in 1934. An expert in high speed photography, he has invented many appliances for the production of momentary flashes for 'instantaneous' photographs. For example, he produced a krypton-xenon gas arc giving a two million watt flash lasting a thirty-thousandth of a second. This was used in connection with vitamin B₂ balance, to photograph the capillaries in the white of the eye without hurting the patient.

Edison, Thomas Alva

American inventor

b. Feb. 11, 1847, Milan, Ohio

d. Oct. 18, 1931

The most prolific inventor of his age, after a very short education Edison began work at the age of twelve and became a telegraph operator. His first patent was for an electrical vote recorder, and from that time onwards a perfect stream of inventions came from him alone and also sometimes from collaboration with others. His carbon transmitter enabled Bell to complete the telephone, his phonograph seems to have been the first, and his incandescent lamp (see Swan) was at least one of the earliest.



THOMAS ALVA EDISON: his last portrait.

He also solved the problem of moving pictures, but regarding them as a toy missed a great opportunity in this field. His up-to-date laboratories employing thousands of workers put the science of invention on an entirely new basis. See Friese-Greene.

Ehrenberg, Christian Gottfried

German naturalist

b. Apr. 19, 1795, Delitzsch, Saxony

d. June 27, 1876, Berlin

After study at Leipzig and Berlin, Ehrenberg became professor of medicine at the latter university in 1827. A great traveller, he accompanied Humboldt through Russia in 1829. He made a special study of rocks composed of minute plant and animal forms and showed that phosphorescence in the sea is due to the presence of organisms. His work on Infusoria (1838) established him as a world authority.

Ehrlich, Paul

German bacteriologist

b. Mar. 14, 1854, Strehlem, Silesia

d. Aug. 20, 1915, Homburg vor der Höhe

Educated at Breslau, Leipzig and Strasbourg, Ehrlich became director of the Royal Institute for Experimental Therapeutics at Frankfurt. In 1908 he shared the Nobel prize for medicine with Metchnikoff. His discovery of the dye, trypan red, which kills trypanosomes, led to his work on disease-killing chemicals. He was famous for his discoveries of

Salvarsan and Neosalvarsan specifics for syphilis. Salvarsan is a selective antiseptic, that is one which kills disease germs but does not attack the tissues, and was the result of trying over six hundred compounds on animals (hence called No. 606). It is very toxic to syphilis spirochaetes. He improved the method of laboratory staining, and advanced the side-chain theory of chemical immunity.

Eijkman, Christiaan

Dutch physician

b. Aug. 11, 1858, Nijkerk

d. Nov. 5, 1930, Utrecht

Beginning as an army surgeon, Eijkman went to Batavia to study beriberi, and became the director of the pathological laboratory there, before becoming professor of hygiene at Utrecht (1898-1928). He was the first to produce experimentally (in fowls) a dietary deficiency disease, thus leading to an understanding of beriberi in humans. This led to the conception of 'essential food factors', and so gave impetus to the development of vitamin research. He shared with Sir F. G. Hopkins the Nobel prize for medicine and physiology in 1929.

Einstein, Albert

Austrian-Swiss-American mathematical physicist

b. Mar. 14, 1879, Ulm, Württemberg.

Educated at Zürich and Munich, Einstein was an examiner in the Patent Office, Berne, when his startling photoelectric theory (the basis of the quantum theory) and his first sketch of relativity theory won him professorships at Zürich and Berlin. In 1933 the thickening shadow of Nazi persecution caused the Jewish and Liberal Einstein to resign his chair and the German nationality he had assumed, and to seek freedom at Oxford and later in America. He became professor at Princeton in 1940. He is the originator of the Theory of Relativity, the special theory which deals with electrodynamics and optics being published in 1905, and the general theory on gravitation about 1915. He has also done important work on the application of the quantum theory. He received the

EINTHOVEN

Nobel prize for physics in 1921, and the Copley medal in 1925. The ideas and speculations of Einstein have effected the most profound revolution in scientific thought since Copernicus. He has pictured a static universe with no motion, as opposed to De Sitter's dynamic universe with no matter. His single field theory has reduced electromagnetism and gravity to one set of formulae (1950), and he has explained among other things the effect of gravity on light, the principles of photoelectric effect, and Brownian movement. The unit of radiant energy, equal to 3.79×10^4 calories, has been named an einstein. He is the author of several books including *The Meaning of Relativity* (1923) and, with Infeld, the popular *Evolution of Physics* (1938).

Einhoven, Willem

Dutch physiologist

b. May 21, 1860, Sclarang, Java

d. Sept. 29, 1927, Leyden

Educated at Utrecht, Einthoven became professor of physiology at Leyden in 1886. He invented a new type of galvanometer, the string galvanometer, which led to the development of the electrocardiograph. In 1924 he was awarded the Nobel prize for medicine.

Ekeberg, Anders Gustaf

Swedish chemist and mineralogist

b. 1767, Stockholm

d. 1813

Educated at Uppsala, Ekeberg became professor of chemistry there and in 1802 discovered the element *tantalum*, which he so named from Tantalus because of the tantalising nature of the search for something to react with it. Ekeberg was partially deaf from childhood and also lost an eye in an experiment.

Elhuyar, Don Fausto d'

Spanish chemist

b. 1755, Logroño

d. 1833, Madrid

After being educated at Paris and studying chemistry and mineralogy in Freiberg, Elhuyar collaborated with his brother, Don Juan, in 1783 in a research on wol-

ramite from which they succeeded in extracting metallic wolfram. He later went to America as Director of Mines of Mexico and then came back to Spain as Director General of Mines.

Elster, Julius

German physicist

b. 1854, Blankenburg, Brunswick

d. 1920, Wolfenbüttel, Brunswick

After completing his education at Berlin and Heidelberg, Elster carried out with Geitel a series of brilliant researches. They produced the first photoelectric cell and photoelectric photometer and a Tesla transformer. Their experiments on the conduction of electricity in gases were of great significance and in 1899 they were the first to determine the charge on raindrops falling from thunder clouds. They proved that lead in itself is not radioactive, and that the conductivity of the atmosphere is caused by ionisation due to the presence of radioactive substances and not by dust. They also showed how wide is the distribution of these substances, and in 1899 stated that they were unstable and tended to break down into an inactive element.

Encke, Johann Franz

German astronomer

b. Sept. 23, 1791, Hamburg

d. Aug. 26, 1865, Spandau, Prussia

After studying at Göttingen under Gauss, Encke served in the Prussian army before becoming principal astronomer at Seeberg and later at Berlin. He determined the orbit of the famous comet of 1680 and in 1819 he investigated a comet discovered by Pons (Encke's comet) and found it had a period of 1,200 days. His estimation in 1824 of the solar parallax from previous work on the transits of Venus held the field for long as the most accurate, and this led him to measure the distance of the sun from the earth.

Engelmann, T. W.

German physiologist

b. 1843

d. 1909

In 1882 Engelmann showed that the chloroplast is activated mainly by the red

end of the spectrum, then by the violet, and that the other parts hardly affect it.

Engler, Adolf (Heinrich Gustav Adolf)
German botanist

b. Mar. 3, 1844, Sagan

d. Oct. 10, 1930, Berlin

In 1889 Engler became professor of botany at Berlin University and director of the botanical gardens and museum there. He is remembered as the author of an important natural classification of plants (*Die natürlichen Pflanzenfamilien*, 1887-1915, 2nd ed. 1924 ff.; *Syllabus der Pflanzenfamilien*, 1923), and for his work on plant geography (*Vegetation der Erde*, 1896 ff. with O. Drude, etc.) He studied also the flora of Africa (*Die Pflanzenwelt Afrikas*, 1908-25).

Eötvös, Roland, Baron von

Hungarian physicist

b. July 27, 1848, Budapest

d. Apr. 8, 1919, Budapest

Educated at Budapest and Heidelberg, Eötvös became professor of physics at the former university in 1872, and later minister of education. He did research on capillarity, gravitation and terrestrial magnetism, and performed experiments on the relation between the surface tension and temperature of liquids. He also constructed the double-armed torsion balance, named after him, which detects local variations in gravity and is of use in the study of underlying geological strata. He was able to demonstrate that a body loses in weight when moving east.

Erasistratus

Greek anatomist

c. 300 B.C., Chios

An Alexandrian physician, possibly a grandson of Aristotle, Erasistratus is sometimes regarded as the founder of physiology. He was court physician to the king of Syria. He was the first to distinguish between the cerebrum and the cerebellum and he noticed also the difference between sensory and motor nerves. He named the trachea, invented a catheter, and did not favour the conception of the humours. It is said that he

practised human vivisection on criminals with the King's permission, but there is considerable doubt as to whether this is true.

Eratosthenes

Greek astronomer

b. 275 B.C., Cyrene

d. 194 B.C.

Educated at Alexandria and Athens, Eratosthenes was distinguished in athletic, literary and scientific circles. In later life he lost his sight through disease, and committed suicide when he was no longer able to read. He suggested the introduction of an extra day into the calendar every fourth year, and measured the obliquity of the ecliptic. He also determined the radius of the earth from a measurement of the length of a degree on its surface, but there is some doubt about the units which he used so that the accuracy of his answer cannot be gauged. Only fragments of his *Geographica* survive; it was used by Strabo. His lost catalogue contained 675 fixed stars.

Ericsson, John

Swedish engineer

b. July 31, 1803, Langbanshyttan, Werm-land

d. Mar. 8, 1889, New York

A draughtsman at the age of twelve, Ericsson later entered the army. Coming to London he produced a locomotive in 1829 for the Rainhill competition (won by Stephenson). His inventions included marine and caloric engines, a screw propeller (not the first, however) and armoured ships. By this time (1839) he had settled in America and the *Monitor*, launched 1862, constructed by him and used in the civil war, ushered in the age of the ironclad warship.

Erlanger, E. Joseph

American physiologist

b. Jan. 5, 1874, San Francisco

Educated at California and the Johns Hopkins University, Erlanger became professor of physiology at the latter and later went to Wisconsin and then Washington in 1910. He is famous for his work

EUCLID

with Gasser on the nervous system, and they shared the Nobel prize for medicine in 1944. Their work is recorded in their *Electrical Signs of Nervous Activity* (1937).

Euclid

Greek mathematician

b. c. 330 B.C.

d. c. 275 B.C.

Probably educated at Athens, Euclid taught at Alexandria, but very little is known of his private life. He is famous for his text-books on geometry which have been in use almost continuously for two thousand years. Chief of these is the *Elements*, whose 13 books, first printed in a Latin translation from the Arabic in 1482, were long the basis of the teaching of geometry. Not until the present century did relativity theory bring non-Euclidean geometry into prominence (see Riemann). Other works are the *Data* (geometry), *Phaenomena* (astronomy), *Section of the Scale*, *Optics* and *Divisions of Superficies*; lost works are *Conics*, *Surface-loci*, *Porisms* and *Pseudaria*. *Introductio Harmonica* and *Catoptrica* are probably not by Euclid. See T. L. Heath, *Manual of Greek Mathematics* (1931).

Euler, Leonhard

Swiss mathematician

b. Apr. 15, 1707, Basle

d. Sept. 18, 1783, St. Petersburg

After studying under Bernoulli at Basle, Euler became professor of physics at St. Petersburg and also professor of mathematics. He became blind in one eye through overwork and the climate. Moving to Berlin by royal command, he stayed twenty-five years before returning to Russia, only to suffer the partial loss of sight in his other eye through cataract. His work on algebraic series added much to existing knowledge and he was the first to point out that such series to be usefully employed must be convergent. In trigonometry he introduced the short forms of the functions and used the symbols π

and ϵ . The coefficients of certain trigonometrical expansions have been named Euler numbers as he was the first to realise their significance, and he made improvements in the differential and integral calculus. He also did work on mechanics, hydrodynamics, acoustics and optics.

Euler-Chelpin, Hans Karl August Simon von

German-Swedish chemist

b. Feb. 15, 1873, Augsburg, Bavaria

Educated at Munich, Berlin, Göttingen and Würzburg, Euler-Chelpin became lecturer in physical chemistry at Stockholm. Further study in Berlin and Paris at the Pasteur Institute led him to be professor of chemistry and director of the Biochemical Institute at Stockholm. He was awarded the Nobel prize for chemistry in 1929 (with Harden) for his researches on enzymes and fermentation.

Eustachio, Bartolomeo

Italian physician

b. 1520

d. 1574

Professor of anatomy at Rome, Eustachio is noted for his re-discovery of the tube named after him which connects the mouth and ear. The original discoverer was the Greek, Alcmaeon. Eustachio investigated also the vocal organs and the nerve supply of muscles. His works were not published until 1714.

Ewart, James Cossar

Scottish zoologist

b. Nov. 26, 1851, Penicuik, Midlothian

d. Dec. 31, 1933

After studying medicine at Edinburgh, Ewart became professor of natural history at Aberdeen in 1878 and then at Edinburgh. He was an expert on fish culture. He conducted a series of experiments on the cross breeding of horses and zebras to disprove the idea known as telegony. He showed that contrary to popular belief the first mate of a female has no influence on her subsequent offspring.

F

Faber, Johannes
German scientist
b. 1574, Bamberg
d. 1629

One of the founders of the first scientific society, named the *Lynx* on account of that animal's piercing sight, Faber suggested the name *microscope* for the recently invented instrument.

Fabre, Jean Henri
French entomologist
b. Dec. 21, 1823, St. Léons, Aveyron
d. Oct. 11, 1915, Sérignan, Provence
Of humble origin, Fabre became a teacher before taking a doctor's degree at Paris. Becoming professor of physics at the College of Ajaccio, he made the study of insects his life work and his original investigations in this field became world famous. He was led, however, by his observations to oppose the evolutionary theory. See A. Fabre, *Jean Henri Fabre*.

Fabricius ab Acquapendente, Hieronymus
Italian anatomist
b. May 20, 1537, Acquapendente (Padua)
d. May 21, 1619, Venice
After studying at Padua, Fabricius succeeded Fallopius there as teacher of anatomy. He was the discoverer of the semi-lunar valves in veins but failed to understand their one-way action. Consequently, it was left to his pupil Harvey to make the great discovery of the true circulation of the blood. His work on embryology was outstanding and he laid the foundations for the study of this subject.

Fabricius, Johann Christian
Danish entomologist
b. Jan. 7, 1745, Tondern
d. Mar. 3, 1808
After studying at Altona; Copenhagen and at Uppsala under Linnaeus, Fabricius

became professor of natural history and economy at Kiel. He is famous for his introduction of a new system of classification of insects based on mouth structure instead of wings.

Fahlberg, Constantin
American chemist
b. 1850
d. 1910
Working at the Johns Hopkins University in 1879, Fahlberg discovered saccharin by synthesis from toluene. He later became a manufacturing chemist.

Fahrenheit, Gabriel Daniel
German physicist
b. May 14, 1686, Danzig
d. Sept. 16, 1736, Holland
After studying natural philosophy in Holland, Fahrenheit became an F.R.S. in 1724. In 1720 he had greatly improved thermometers by introducing mercury instead of spirits of wine. This had been done in 1659 by Boulliau, but difficulties in construction had prevented its adoption. He made several valuable discoveries in physics amongst which was the important fact that the boiling point of a liquid varies with atmospheric pressure, but he is chiefly remembered for his invention of the Fahrenheit scale. In this he divided the interval between ice-water-salt and blood temperatures into 96 parts (0-96), the present scale being a later modification. He discovered that water could be cooled below its freezing point without solidification.

Fajans, Kasimir
Polish-American physical chemist
b. May 27, 1887, Warsaw
Educated at Leipzig, Heidelberg and Manchester, Fajans was professor of chemistry at Munich from 1917-35 and then at Michigan in 1936. Independently of Soddy he formulated the theory of isotopes

FALLOPIUS

(see also Aston) that is, of elements having the same atomic number but different atomic weights. In 1913 with Göhring he showed that uranium X_1 disintegrates by beta-ray emission into uranium X_2 (called by them *brevium*, on account of its very short life). He also worked on the age of minerals in Norway by measuring the percentage of the radioactive end-product, lead, and in 1919 did research on the *energies of hydration* of ions, showing how the quantity might be determined. This is the energy liberated when a free ion in the gaseous state is introduced into water. Fajans is the author of *Radio-activity and Latest Developments in the Study of Chemical Elements* (1919, Eng. ed 1922) and *Radioelements and Isotopes* (1931).

Fallopious, Gabriel (Gabiello Fallopio)

Italian anatomist

b. 1523, Modena

d. Oct. 9, 1562

Educated at Modena for the church, Fallopious became a canon. Later he studied medicine at Ferrara and became teacher in medicine, succeeding Vesalius at Padua. He is noted for his work on the generative organs and on the ear, and in

particular for the discovery of the Fallopian tubes or oviducts. He introduced the names *ovarian tubes*, *vagina* and *placenta*.

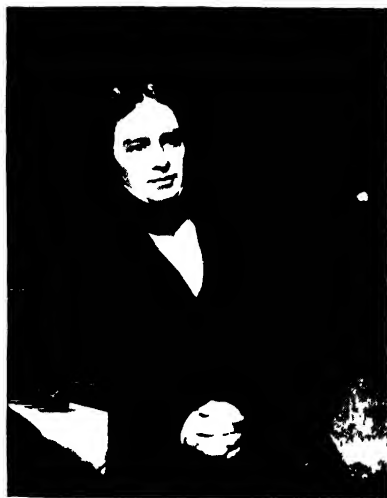
Faraday, Michael

English physicist and chemist

b. Sept. 22, 1791, Newington Butts, London

d. Aug. 25, 1867, Hampton Court, Twickenham

Born in poor circumstances, as a boy Faraday worked for a bookbinder. After reading scientific books he attended Davy's lectures and his notes so impressed Davy, to whom he had sent them with a request for employment, that he was engaged as Davy's assistant in 1813. He advanced rapidly and became professor of chemistry at the Royal Institution in 1833. His fame rests chiefly on his discovery of electromagnetic induction and of specific inductive capacity. He introduced the term *dielectric* to indicate a medium across which induction can take place, and proved the identity of animal and frictional electricity. In 1831 Faraday discovered how to produce electromotive force by the movement of a conductor in a magnetic field, thus preparing the way for the development of the generator. His work on electrolysis was outstanding and he introduced the terms *electrode*, *anode*, *cathode*, *anion*, *cation*, *ion* and *ionisation*. He proved that the amount of decomposition is proportional to the current strength and the time, that is, to the quantity of electricity passing, and that the weight of a substance deposited is in proportion to its chemical equivalent weight. He discovered the rotation of plane polarised light by a magnetic field, and succeeded in liquefying chlorine and other gases. The farad, named after him, is the unit of electrical capacity. Among other works he wrote *Experimental Researches in Electricity* (1844-55). See S. P. Thompson, *Michael Faraday: his Life and Work* (1898).



MICHAEL FARADAY

Faye, Hervé Auguste Étienne Albans

French astronomer

b. 1814, St. Benoît-du-Sault

d. 1902

A professor at the École Polytechnique in

1873, Faye became director of the Paris Observatory in 1878. He discovered in 1843 the comet which bears his name, and brought forward a theory connecting sun-spots with weather (1872).

Fehling, Hermann von
German chemist

b. June 9, 1812, Lübeck

d. July 1, 1885, Stuttgart

After studying under Liebig, Fehling became professor of chemistry at Stuttgart. He is remembered as the introducer of the well-known solution, named after him. This, a solution of cupric sulphate and potassium sodium tartrate (Rochelle salt) in alkali, is used as an oxidising agent. It is also an important analytical reagent for aldehyde, glucose, fructose, etc., which reduce it to cuprous oxide. Fehling also worked out the composition of paraldehyde and metaldehyde, and prepared phenyl cyanide.

Fermat, Pierre

French mathematician

b. Aug. 17, 1601, Beaumont-de-Lomagne, nr. Montauban

d. Jan. 12, 1665, Castres, nr. Toulouse

An associate of Pascal in his youth, Fermat was the founder of the modern theory of numbers and his work paved the way for the differential calculus. He wrote a book on maxima and minima which led to controversy with Descartes, and he also worked on the reflection of light and evolved the principle of least time. Perhaps his most famous theorem is the one known as *Fermat's last theorem*, which states that if x , y , and z are integers other than zero then

$$x^n + y^n = z^n$$

cannot be true where $n > 2$. He scribbled this on the margin of a book but never published the general proof, which has evaded mathematicians ever since. *Fermat's numbers* are defined by $2^{2^n} - 1$, but are not all prime as he thought. *Fermat's principle*, the first variational principle of physics, postulates that a light ray traversing different media takes the path of least duration. Pascal and Fermat framed the first outlines of probability. Fermat was

a lawyer and linguist whose interest in mathematics, in spite of the number and value of his contributions, remained that of an amateur.

Fermi, Enrico

Italian physicist

b. Sept. 29, 1901, Rome

Educated at Göttingen and Leyden, Fermi became professor of physics at Rome. He gained the Nobel prize for physics in 1938 for research on the making of artificial radioactive substances. In 1934 he was the first to bombard nuclei of heavy elements with neutrons and thus to obtain transmutations. Since 1939 he has been professor of physics at Columbia University. In 1942 he was responsible for the construction of the first atomic pile.

Ferrier, Sir David

British neurologist

b. Jan. 13, 1843, Aberdeen

d. Mar. 19, 1928, London

Educated at Aberdeen, Heidelberg and Edinburgh, Ferrier eventually became professor of medicine at King's College, London, and then professor of neuropathology. He was elected F.R.S. in 1876. Famous for his researches on the brain, he did original work on the localisation of cerebral functions, raising this branch of knowledge to the dignity of a separate science. The removal of brain tumours was a practical result of this line of study. His necessary experiments on living animals led to attacks being made on him by the anti-vivisectionists.

Fibiger, Johannes Andreas Grib

Danish pathologist

b. Apr. 23, 1867, Silkeborg

d. Jan. 30, 1928, Copenhagen

Educated at Berlin under Koch and Behring, Fibiger worked at Copenhagen and eventually became professor and head of the Institute of Pathological Anatomy there. Noted for his work on cancer, he is known as the first to induce this disease experimentally. His work was done on rats and he infected them by feeding with a special type of cockroach which carried

FICK

the parasite *Spiroptera neoplastica*. In 1926 he was awarded the Nobel prize for medicine for his discovery of the *Spiroptera* carcinoma.

Fick, Adolph

German physiologist

b. 1829

d. 1901

Fick discovered a law of diffusion in liquids, named after him, which states that the mass of solute which diffuses through unit area per second is proportional to the concentration gradient.

Finck, Thomas

Danish mathematician

b. 1561, Denmark

d. 1646

In 1583 Finck wrote a book on geometry in which the words *secant* and *tangent* are used for the first time.

Findlay, Alexander

Scottish chemist

b. Sept. 24, 1874, Benholm, Kincardine

Educated at Aberdeen and Leipzig (under Ostwald), Findlay became professor of chemistry in the University College of Wales and later occupied a similar post at Aberdeen. He is an authority on the phase rule and has written a book so titled which is the standard work on the subject.

Finsen, Niels Ryberg

Danish physician

b. Dec. 15, 1860, Thorshavn, Faroes

d. Sept. 24, 1904, Copenhagen

Of Icelandic parentage, Finsen was educated at Copenhagen, and was in 1896 the first to recognise the curative effects of ultra-violet light, especially with regard to lupus. He began modern light-therapy at the institute at Copenhagen named after him, and discovered that screening from ultra-violet rays prevents suppuration in smallpox. He was awarded the Nobel prize for medicine in 1903.

Fischer, Emil Hermann

German chemist

b. Oct. 9, 1852, Euskirchen, nr. Cologne

d. July 15, 1919, Wannsee, Berlin

Trained under Kekulé at Bonn and Baeyer in Strasbourg in 1874, Fischer eventually succeeded Hofmann at Berlin in 1892, after holding similar appointments at Erlangen and Würzburg. He gained the Nobel prize for chemistry in 1902, and was recognised as one of the greatest organic chemists of the last century. He was especially noted for his synthesis of many substances, e.g., the sugars dextrose, fructose and mannose, and caffeine, uric acid, veronal, hydrazine, rosaniline, purines and polypeptides.

Fischer, Hans

German chemist

b. July 30, 1881, Höchst a.M.

d. 1945, Munich

After studying at Lausanne, Marburg and Munich, Fischer rose to be professor at the latter university, and after holding other similar appointments elsewhere, returned to be professor of organic chemistry and director of the Institute at Munich. He was awarded the Nobel prize for chemistry in 1930 for his researches on haemin, the porphyrins, chlorophyll and other related compounds. He died by his own hand.

Fischer, Otto Philip

German chemist

b. 1852, Euskirchen, nr. Cologne

d. 1932

A cousin of Emil (see above), Fischer studied at Bonn, Strasbourg and Munich. He became professor of chemistry at Erlangen in 1905. With Emil he did research on the hydrazines and he also studied dyes. He prepared the first synthetic alkaloid (kairine.)

Fitch, John

American inventor

b. Jan. 21, 1743, Windsor, Conn.

d. July 2, 1798, Bardstown, Kentucky

One of the claimants for the title of inventor of the steamship, Fitch is said to have constructed a model in 1785. He built three boats between 1785 and 1788, the first of which worked by mechanical oars. He later attempted to spread his ideas in Europe and obtained a French patent, but

the year was 1793 and the Revolution defeated his efforts. Working his passage back to America as a seaman he attempted to build a screw-driven boat but failed, and he died shortly afterwards, it has been said by his own hand.

Fittig, Rudolf

German organic chemist

b. Dec. 6, 1835, Hamburg

d. Nov. 19, 1910, Strasbourg

After studying at Göttingen, Fittig became professor of organic chemistry at Tübingen in 1869 and at Strasbourg in 1876. He is famous for his work on the synthesis of organic compounds, e.g., the lactones. With Tollens in 1864 he synthesised toluene, and he discovered diphenyl, phenanthrene (1872) and coumarone (1883).

Fitz, Reginald Heber

American pathologist

b. 1843, Chelsea, Mass.

d. 1913

A Boston surgeon, Fitz is noted for his research on, and suggested operative treatment for, appendicitis, which he named, and in particular for his study of its relation to peritonitis (*Perforating Inflammation of the Vermiform Appendix*, 1886).

Fitzgerald, George Francis

Irish physicist

b. Aug. 3, 1851, Dublin

d. Feb. 21, 1901, Dublin

Educated at Dublin, Fitzgerald became professor of natural philosophy there (1881-1901), and an F.R.S. in 1883. He was the first to suggest, considering the Michelson-Morley experiment, that a material moving through an electromagnetic field would show contraction in the direction of motion; this is referred to as the Lorentz-Fitzgerald contraction. He also was the first to propose that the tail of a comet consists of small stones (diam. < 1cm.) while the head consists of large stones, thus explaining the repulsion of the tail of a comet by the pressure of light radiation from the sun. His researches included electrolysis and electromagnetic radiation.



JOHN FLAMSTEED

Fizeau, Armand Hyppolyte Louis

French physicist

b. Sept 23, 1819, Paris

d. Sept. 18, 1896, Venteuil

Sufficiently wealthy to be able to follow his natural inclination to study physics, Fizeau as a result was in 1849 the first to measure the velocity of light by an experiment confined to the earth's surface. His result was 315×10^6 metres/sec. He later collaborated with Foucault in an improved method but the partnership came to an end before it could be tested. Both scientists presented independent results in 1850. He interpreted the Doppler principle and showed how it could be used to determine star velocity in the line of sight.

Flammarion, Nicolas Camille

French astronomer

b. Feb. 25, 1842, Montigny-le-Roi, Haute-Marne

d. June 4, 1925, Paris

After being trained in theology, Flammarion entered the Paris Observatory in 1858. One of his chief discoveries was

FLAMSTEED

that of the common proper motion of widely separated stars, and he made many planetary and lunar observations. These included the noting in the crater Plato of slight colour changes which he attributed to primitive vegetation. He was well-known for his popular books on astronomy, and was the founder in 1887 of the French Astronomical Society.

Flamsteed, John

English astronomer

b. Aug. 19, 1646, Denby, nr. Derby

d. Dec. 31, 1719, Greenwich

Educated at Cambridge for the church,

Flamsteed became instead the first Astronomer Royal (1675); from 1684 on he held the living of Burston. Besides his astronomical work he is distinguished as the inventor of the conical projection in map-making. He made the first trustworthy catalogue of stars. He had a rooted objection to the publication of his works before he considered them complete, and this led to violent controversy between other scientists and himself. His long quarrel with Newton was an instance of this. His great account of his observations is *Historia Coelestis Britannica* (pub. 1725).

Fleming, Sir Alexander

Scottish bacteriologist

b. Aug. 8, 1881, Loudoun, Ayrshire

Educated at Kilmarnock and St. Mary's Hospital, London, Fleming became professor of bacteriology at London University. Famous for his discovery of penicillin in 1929, he was awarded the Nobel prize for medicine with Chain and Florey in 1945.

Fleming, Sir John Ambrose

English physicist

b. Nov. 29, 1849, Lancaster

d. 1945

After studying at London and Cambridge, Fleming became professor of electrical engineering at London from 1885 to 1926. He worked with Dewar on electrical resistance at low temperatures. He was the inventor of the thermionic valve, and contributed much to the development of the electric lamp and electric lighting. He was the author of several books on electricity.

Flemming, Walther

German biologist

b. Apr. 21, 1843, Sachsenberg

d. Aug. 4, 1915, Kiel

A biologist of Prague and Kiel, Flemming was a pioneer in cytology and introduced the term *mitosis* to describe the indirect process of cell division, which he and Strasburger worked out. He also invented other terms, e.g., chromatin, spireme and aster. His work on the splitting of chro-



SIR ALEXANDER FLEMING: a medal in honour of his discovery, struck by La Monnaie 1949.

mosomes initiated intra-nuclear research on germ cells, and he was a pioneer in the use of the microscope.

Flettner, Anton
German engineer
b. 1885

One of the pioneers in the investigation of remote control of machines by radio, Flettner invented a tank so controlled in 1915. In 1924 he also invented the rotorship, with metal sails which could be rotated round the masts to take advantage of the wind. This has not proved to be a commercial success.

Florey, Sir Howard Walter
English pathologist
b. Sept. 24, 1898, Adelaide
Educated at Adelaide, Oxford and Cambridge, Florey became professor of pathology at Oxford in 1935 after holding similar posts elsewhere. Elected F.R.S. in 1941 he shared the Nobel prize for medicine in 1945, and is particularly noted for his part in the development of penicillin in association with Dr. E. B. Chain.

Floyer, Sir John
English physician
b. 1649, Hinters, Staffs.
d. Feb. 1, 1734, Lichfield
Educated at Oxford, Floyer became a physician at Lichfield. He introduced the first accurate measurement of the pulse by his invention of the pulse watch, a special watch running for one minute and reading in seconds. This he described in *The Physician's Pulse Watch* (1707). Sanctorius had invented his pulsilogium a hundred years earlier.

Fontana, Franciscus
Italian astronomer
c. 1600
A resident at Naples, Fontana was one of the earliest astronomers to use a telescope, and in 1636 was the first to see markings on Mars. In 1643 he noticed irregularities on the inner edge of the crescent of Venus. He was probably the first to use a convex instead of a concave eyepiece in a microscope.

Fontenelle, Bernard Le Bovier de
French author
b. Feb. 11, 1657, Rouen
d. Jan. 9, 1757, Paris
Though a writer rather than a scientist, Fontenelle in *Entretiens sur la Pluralité des Mondes* (1686) did much to further the cause of the astronomy of Descartes. His scientific journalism eventually gained him membership of the Academy of Sciences, though not without opposition. He lived a very long and full life, and was one of the most versatile intellects of the day.

Forbes, Edward
British naturalist
b. Feb. 12, 1815, Douglas, Isle of Man
d. Nov. 18, 1854, Edinburgh
After studying medicine at Edinburgh, Forbes turned to natural history and subsequent to a period of travel became curator of the museum of the Geological Society at London. In 1843 he was appointed professor of botany at King's College and was palaeontologist for the geological survey of Great Britain. He eventually became professor of natural history at Edinburgh. He is noted for his division of British plants into five groups which he considered migrated to these islands at three distinct periods over continuous land.

Forbes, George
English physicist
b. 1849
d. Oct. 22, 1936
Educated at Cambridge, Forbes covered a wide range in his researches. He invented the carbon brush for dynamos and perfected a range-finder for naval guns. In 1880 with Young, he improved on Fizeau's method of measuring the velocity of light, and obtained a result of 301.382×10^6 metres per second. In the same year he predicted the existence of a trans-Neptunian planet (Pluto) from evidence relating to families of comets attached to planets.

Forbes, James David
Scottish physicist
b. Apr. 20, 1809, Edinburgh
d. Dec. 31, 1868, Clifton, Bristol

FOREL

Educated at Edinburgh, Forbes became a lawyer. In 1833, however, he left the law and became professor of natural philosophy at Edinburgh, being elected F.R.S. in 1832. He did research work on the polarisation of radiant heat by tourmaline crystals. His most famous work was that on glaciers in which he proved that the ice moves like a viscous fluid.

Forel, August Henri

Swiss entomologist and psychologist

b. Sept. 1, 1848, Morges

d. July 27, 1931, Yvorne

Professor of psychiatry at Zürich (1879-98), Forel was noted for his work on the anatomy of the brain and nerves. He was an authority on the psychology of ants, and his researches also included work on hypnotism and sex hygiene.

Foucault, Jean Bernard Léon

French physicist

b. Sept. 18, 1819, Paris

d. Feb. 11, 1868, Paris

After studying medicine and physics, Foucault became assistant in physics at the Paris Observatory (1855). He invented a very accurate method of testing a lens for chromatic and spherical aberration, and worked, both with Fizeau and independently, to determine the velocity of light by an experiment in the laboratory. He proved that light travels slower in water than in air (1850). He was the first to observe that the plane of oscillation of a pendulum will rotate with an angular velocity of $\omega \sin \theta$, where ω is the angular velocity of the earth about its axis, and θ the latitude of the site of the pendulum, this being a measure of the earth's axial rotation. Foucault's pendulum is a long pendulum set up to show this relative motion. In 1852 he constructed the gyroscope, in 1857 the Foucault prism, and in 1858 improved the mirrors of reflecting telescopes.

Fourcroy, Antoine François, Comte de

French chemist

b. June 15, 1755, Paris

d. Dec. 16, 1809, Paris

After graduating in medicine, Fourcroy

turned to chemistry and became professor of chemistry at the Jardin du Roi. He was associated with Lavoisier and Berthollet in some of their great discoveries and in their new chemical nomenclature, and wrote a *Philosophie Chimique*.

Fourier, Jean Baptiste Joseph, Baron

French mathematician

b. Mar. 21, 1768, Auxerre, Yonne

d. May 16, 1830, Paris

The son of a tailor, Fourier was educated at a military school and became professor of analysis at the École Polytechnique. He went to Egypt with Napoleon, becoming governor of Lower Egypt, and on his return to France was made a Prefect, but was later deprived of his office. He then devoted himself to mathematics. He is remembered for his discovery of the fact that any function of a variable can be expanded in a series of sines of multiples of the variable. This theorem (Fourier series) has proved invaluable in analysis.

Fournier d'Albe, Edmund Edward

English physicist and inventor

b. 1868, London

d. July, 1933

While working as a physicist in Dublin, Fournier d'Albe contributed to the Pan-Celtic movement by the writing of an English-Irish dictionary (1903). In science he is remembered as the inventor (1912) of the optophone with which blind people can read a book by ear. This machine converts light energy into sound. He also produced several inventions connected with radio, e.g., methods of telewriting and telephotography. In 1923 he was the first to transmit a portrait from London. His many publications include *The Electron Theory* (1906) and *Wonders of Physical Science* (1911).

Fracastorius, Hieronymus; Girolamo

Fracastorio

Italian physician

b. 1483, Verona

d. Aug. 8, 1553, Cusi, nr. Verona

After studying mathematics, geology and astronomy as a contemporary of Copernicus at Padua, Fracastorius practised medi-

FRAUNHOFER

cine, and soon became a popular figure. He gave the name *syphilis* to the venereal disease, and was the first to recognise typhus fever.

Franck, James

American physicist

b. Aug. 26, 1882, Hamburg

Of German origin, Franck was educated at Berlin and Heidelberg. He was professor at Berlin in 1915, at Göttingen in 1920 and at the Johns Hopkins University in 1935. In 1938 he became professor of physical chemistry at Chicago. His work with G. Hertz on the quantum theory and in particular on the impact of electrons on atoms earned for him jointly with Hertz the Nobel prize for physics in 1925. In 1939 he joined the team of American physicists working on atomic energy.

Frank, Albert Bernhard

German botanist

b. 1839

d. 1900

In the course of research on plants, Frank showed that in some higher types, germination is impossible without the aid of

fungus companions. He named these fungi *Mycorrhiza*. This is an example of symbiosis.

Frankland, Sir Edward

English organic chemist

b. Jan. 18, 1825, Churchtown, Lancs.

d. Aug. 9, 1899, Golaa, Norway

After studying under Playfair in London, and under Bunsen and Liebig at Marburg and Giessen, Frankland became professor of chemistry at Manchester in 1851, and in London at the Royal Institution as successor of Faraday in 1863. He was elected F.R.S. in 1853 and gained the Copley medal in 1894. He put forward a theory of valency (1852 to 1860), and did much towards the introduction of modern structural formulae. In 1868 with Lockyer he discovered helium in the sun's atmosphere. He was an authority on sanitation and river pollution.

Franklin, Benjamin

American scientist and politician

b. Jan. 17, 1706, Boston

d. Apr. 17, 1790, Philadelphia

As a young man, Franklin worked in the printing trade and rose to be a publisher; in 1746 he became interested in science and was subsequently the first to prove the identity of lightning with electricity. He invented the lightning conductor. Later in life he deserted science for politics and it is for his activities in that field that he is chiefly remembered.

Fraunhofer, Joseph von

German optician and physicist

b. Mar. 6, 1787, Straubing, Bavaria

d. June 7, 1826, Munich

The son of a poor glazier, Fraunhofer was apprenticed to a glass polisher in Munich in 1799, and eventually rose to be partner in a firm of optical instrument makers. He was a brilliant lens maker and the constructor of the finest refractors of his time. The first to study carefully the dark lines in the solar spectrum which had been seen by Wollaston in 1802 and which now go under Fraunhofer's name, he plotted 576 of them but was unable to explain



BENJAMIN FRANKLIN

FREEMAN

them. He investigated the spectra of other heavenly bodies, and invented a heliometer, and a diffraction grating for measuring wave-lengths. The hardship of his life as a youth contributed to his early death from tuberculosis.

Freeman, Walter

American neurologist

b. Nov. 14, 1895, Philadelphia, Pa.

Educated at Yale, Pasadena, Paris and Rome, Freeman became director of the laboratories at St. Elizabeth's Hospital, Washington, and specialist in neurology in 1926. He has published books on neuropathology (1933) and psychosurgery (1941) and is one of the greatest living authorities on these branches of medicine. With Dr. J. W. Watts he has developed the operation known as prefrontal lobotomy, which is increasingly used in relief of psychasthenia and manic-depression. The treatment, introduced by Moniz in 1935 and known also as leucotomy, consists of scission of the association fibres between the frontal lobes and the thalamus.

Frémy, Edmond

French chemist

b. Feb. 28, 1814, Versailles

d. Feb. 3, 1894, Paris

A pupil of Gay-Lussac, Frémy became professor of chemistry at the École Polytechnique and later at the Muséum d'Histoire Naturelle. He was one of the first to prepare fluorine but was unable to collect it, succeeding, however, in the preparation of anhydrous hydrogen fluoride. He wrote a treatise on the synthesis of rubies and prepared artificial examples, and did much work on the ferrates, stannates, plumbates, the colouring of flowers, and saponification of fats.

Fresenius, Karl Remigius

German chemist

b. Dec. 28, 1818, Frankfort-on-Main

d. June 11, 1897, Wiesbaden

After studying at Bonn, and at Giessen as a pupil of Liebig's, Fresenius became professor of chemistry in Wiesbaden. He carried on the work of Berzelius and prepared tables for qualitative and quantitative

analysis which in revised editions are still in use.

Fresnel, Augustin Jean

French physicist

b. May 10, 1788, Broglie, Normandy

d. July 14, 1827, Ville-d'Avray, nr. Paris

Educated at Caen and in Paris, Fresnel became an engineer in Paris but his fortunes varied with the régime. In the course of his experiments, which were done with apparatus built by himself and the village blacksmith, he was the first investigator to produce effects undoubtedly due to the interference of light; these interference effects are known as Fresnel's fringes. This supplied final, decisive evidence in support of Huygens' wave theory of light. He proved by experiment that white light is composed of numerous waves whose length decreases from red to violet in the spectrum. He invented a biprism to show fringes, and did much to explain the polarisation of light, devising his rhomb for obtaining circularly polarised light. His theories of light while not altogether dynamically sound were in close agreement with the experimental results of the time, and he did much to advance the wave theory. In 1819 he was the first to replace lighthouse reflectors with lenses. Fresnel's reflection formula gives the fraction of incident light reflected at the surface of a transparent medium. His work was little appreciated during his lifetime.

Freud, Sigmund

Austrian psychologist

b. May 6, 1856, Freiberg, Moravia

d. Sept. 23, 1939, London

After studying at Vienna and Paris, Freud became professor of neuropathology at Vienna in 1902. He was eventually forced to come to England by the Nazi persecution of the Jews, and he lived the remaining year of his life in London. The founder of psycho-analysis he is particularly famous for his interpretation of dreams as a method of diagnosing the cause of hysteria, etc. The Freudian school of psycho-analysis stresses the over-riding importance of the libido, regarded as the vital energy attached to the sexual

impulse. Jung and Adler broke away from this conception by insisting upon the importance of the libido as will-to-live and will-to-power respectively, and substituted free association of ideas as a diagnostic. Freud experimented with hypnosis as a cure for neurosis (see Breuer), but abandoned it as unsatisfactory, and turned to free association. He evolved a theory of the personality, as *id*, *ego* and *superego* (or roughly, *instinct*, *will* and *conscience*), and emphasised the importance of forgotten or repressed experience in present mental states. Among his works are *Psychopathology of Everyday Life* (1901 and 1914), *The Interpretation of Dreams* (1913) and *Totem and Taboo* (1913 and 1919).

Freundlich, Herbert

German chemist

b. 1880

Professor of chemistry at Brunswick University from 1911, Freundlich moved to a similar post at Berlin in 1923. He is noted for his work on capillarity and colloid chemistry, and has introduced an empirical relationship between the amount of a substance adsorbed and the solute concentration.

Friedel, Charles

French chemist

b. Mar. 12, 1832, Strasbourg

d. Apr. 20, 1899, Montauban

From the École des Mines, Friedel went to the École Normale and eventually became professor of mineralogy at the Sorbonne, and then professor of organic chemistry. He did much work on the production of artificial minerals (diamonds) and the pyroelectric phenomena of crystals; also on ketones and aldehydes. The results of his diamond experiments were too small for analysis but the powder was hard enough to scratch corundum. With Crafts he evolved a reaction, named after them, for the synthesis of benzene homologues.

Fries, Elias Magnus

Swedish botanist

b. Aug. 15, 1794, Femsjö, Småland

d. Feb. 8, 1878

From the chair of botany at the University of Lund where he was educated, Fries



SIGMUND FREUD, at the age of eighty-two, arrives in Paris with his daughter Anna, after leaving Vienna for the last time in June, 1938, under the shadow of the coming storm.

moved to a similar post at Uppsala in 1836. His work covered the whole field of botany and he is noted for the introduction of a system of classification based on morphology and biology. The genus *Freesia* is named after him.

Friese-Greene, William

English inventor

b. 1855

d. 1921

Friese-Greene was a pioneer of the motion-picture industry in Britain. He was first to use sensitised celluloid film instead of glass plates, and in 1889 he showed his first film to an audience of one—a passing policeman; and in the same year he took out the first patent for an intermittent-motion device for cameras, whereby the movement of the film between exposures was shielded by a rotating shutter. He devoted the rest of his life to cinematography, including colour and stereoscopic films, but died almost penniless. The Lumière brothers' camera used the first claw and perforation method of moving the film.

FRISCH

Frisch, Otto Robert

Austrian physicist

b. Oct. 1, 1904, Vienna

Educated at Vienna and other universities, Frisch took part in the atomic bomb project. With Meitner he introduced the term 'nuclear fission' in a hypothesis produced in 1939. He became head of the nuclear physics division at Harwell, and in 1947 Jacksonian professor of natural philosophy, Cambridge. He was elected F.R.S. in 1948. Among his publications are *Meet the Atoms* (1947), and papers on nuclear physics.

Froude, William

English engineer

b. Nov. 28, 1810, Dartington, Devon

d. May 4, 1879, Simonstown, S. Africa

Brother of J. A. Froude the historian, he was educated at Oxford and became a civil engineer, first on railway and then on naval work. He was the discoverer of the law of comparison named after him, which enables us to calculate the necessary force required to tow an object against the retarding wave raised by its own progress in the liquid.

Fuchs, Leonhard

German botanist

b. Jan. 17, 1501, Wemdingen, Bavaria

d. May 10, 1566, Tübingen

Educated at Ingolstadt, Fuchs became professor of medicine at Tübingen in 1535.

He published in 1542 a book on botany which was a landmark in natural history on account of its excellent illustrations. His name is commemorated in that of the beautiful fuchsia plants.

Fulton, Robert

American engineer

b. 1765, Little Britain (Fulton), Lancaster, Pa.

d. Feb. 24, 1815, New York

After beginning as a portrait painter, Fulton turned to invention, and having met Watt and others in England became interested in steam power. In France in 1803 he succeeded in using steam power to drive a boat, and on his return to America his *Clermont* was the first steamship with commercial prospects (1807). He thus anticipated Bell in construction though the idea was not his originally. He invented also a submarine.

Funk, Casimir

Polish-American biochemist

b. Feb. 23, 1884, Warsaw

Educated at Warsaw, Geneva and Berne, Funk worked at the Pasteur Institute and in Berlin and London hospitals before going to the U.S.A. and taking up biochemical appointments there. He has played an important part in the development of vitamins, being responsible for so naming them, and has written *L'Histoire de la Découverte des Vitamins* (1924).

G

Gadolin, Johan

Finnish chemist

b. 1760, Åbo (Turku)

d. 1852, Wirmo

Educated at Åbo and Uppsala, Gadolin became professor of chemistry at the former university. He isolated the oxide of yttrium from the mineral later named *gadolinite* in honour of his discovery. This led eventually to the discovery of a whole series of oxides (or rare earths as they were then called).

Gaffky, Georg Theodor August

German bacteriologist

b. Feb. 17, 1850, Hanover.

d. Oct. 23, 1918, Hanover

A member of the German cholera commission which went to Egypt and India, Gaffky isolated and cultivated the bacillus of typhoid (1884).

Gahn, Johan Gottlieb

Swedish chemist and mineralogist

b. 1745, Voxna, Gävleborg

d. 1818, Stockholm

Trained as a miner, Gahn later studied mineralogy under Bergman, and in 1774 was the first to prepare metallic manganese on a reasonable scale. I. G. Kaim had prepared a little manganese in 1770 but his work passed unnoticed. With Scheele in 1770, Gahn discovered phosphoric acid in bones.

Galen

Greek physician

b. 130, Pergamum, Asia Minor

d. 200 (?), Sicily (?)

At the age of sixteen Galen began to study medicine and to write, and when twenty he studied at Alexandria. He was surgeon to the gladiators at Pergamum for four years and then went to Rome where he became physician to the emperor. He dissected and studied the Barbary ape (now confined to Gibraltar) and so drew

conclusions about human anatomy by analogy; and he was the first to appreciate the value of the pulse as a help in diagnosis. Though inclined to be boastful and dogmatic his influence was widespread and longlasting, in spite of some peculiar errors—his opinion, for example, that the windpipe communicated directly with the heart. Nevertheless his many treatises long remained standard textbooks in the Greek, Roman, Arabian and medieval European medical schools.

Galilei, Galileo

Italian astronomer

b. Feb. 15, 1564, Pisa

d. Jan. 8, 1642, Arcetri, Florence

The son of a Florentine nobleman, Galileo was educated at the University of Pisa, and became professor of mathematics there in 1589, at Padua in 1592, and later



GALILEO GALILEI, old and blind, in retirement at Arcetri: from a portrait by Bassano.

GALL

at Florence. In 1583 the swinging of a lamp in the cathedral at Pisa, which he timed with his pulse, led him to deduce the laws of oscillation of a pendulum, and he later applied this to the measurement of time. He was the inventor of the hydrostatic balance, and the author of an attempt to determine the velocity of light by timing a lamp flash between two distant points. The experiment, however, was rendered nugatory by the smallness of the interval of time to be measured. As a result of the famous experiments on bodies dropped from the leaning tower of Pisa (so the story goes), he demonstrated that in a vacuum all bodies would fall with equal velocity; he gained some grasp of the laws of motion enunciated later by Sir Isaac Newton, and showed the parabolic trajectory of projectiles. He discovered also the mechanical principle that what is gained in power is lost in speed, and he invented an air thermometer. The first telescope of practical value came from his hands, and with it he discovered the mountains on the moon, Jupiter's satellites, Saturn's rings, the phases of Venus, sun-spots (from which he inferred the sun's rotation); and he suggested that the Milky Way would be resolved into individual stars by a better telescope. His championship of the Copernican theory in *Letters on the Solar Spots* (1613) and again in 1632, led to his persecution by the church, and the loss of his academic posts. When retired at Arcetri, though almost blind, he still was able to discover the libration of the moon. Domestic trouble and disease made his later years miserable. See F. S. Taylor, *Galileo and the Freedom of Thought* (1938). His works were edited by Favaro (20 vols. 1890).

Gall, Franz Joseph

German physiologist

b. Mar. 9, 1758, Tiefenbronn, Baden

d. Aug. 22, 1828, Paris

Educated at Baden, Strasbourg and Vienna, where he practised as a physician, Gall was the first to stress the importance of the gray matter of the brain as opposed to the white, but was mistaken in attributing specific faculties to the shape of the brain

or skull. This led to the so-called science of phrenology, since discredited.

Galois, Évariste

French mathematician

b. Oct. 25, 1811

d. May 31, 1832

Noted for his work on algebraic equations, Galois was responsible for the important idea of group substitutions. At the age of twenty he was killed in a duel.

Galton, Sir Francis

English anthropologist

b. Feb. 16, 1822, Birmingham

d. Jan. 17, 1911, Haslemere, Surrey

A cousin of Charles Darwin, Galton was educated at King's College, London, and at Cambridge. After travelling in Africa he devoted his time to the study of eugenics and left money in his will to found the Chair of Eugenics at London. In his well-known *Inquiries into Human Faculty* (1883) he investigated the thought processes in men of differing intellectual ability (the origin of mental testing). Among his results was the conclusion that highly educated people had on the whole a smaller capacity for recalling vivid images than the uneducated. His study of fingerprints led to the adoption of them as a means of criminal identification. He made important contributions to meteorology, introducing for example the idea of an anticyclone which he so named. His work reveals an inclination to place too much reliance on statistics, as illustrated by his table showing the incidence of mutual ill-temper in married couples, his map showing the distribution of beauty in Great Britain, and his attempt to estimate the efficacy of prayer.

Galvani, Luigi or Aloisio

Italian physician and physiologist

b. Sept. 9, 1737, Bologna

d. Dec. 4, 1798, Bologna

A professor of anatomy at Bologna in 1762, Galvani is famous for his theory of galvanism or animal electricity. By experiments on frogs he showed that if a nerve is stimulated in a certain way the

muscle to which it leads will contract, but he did not arrive at a correct interpretation of this. Volta showed that this stimulus is electrical, and the galvanic or voltaic battery commemorates their work.

Garcia, Manuel

Spanish-French teacher of singing

b. Mar. 17, 1805, Madrid

d. 1906, London

A well-known teacher of singing, and professor at the Paris Conservatoire and at the Royal Academy of Music in London, Garcia was the inventor (1855) of the laryngoscope which laid the foundation of the modern study of the larynx.

Garner, William Edward

English chemist

b. 1889.

Educated at Birmingham, Göttingen and London, Garner held academic posts at the first and last named before going to Bristol as professor of physical chemistry. He was elected F.R.S. in 1937. He is noted for his work on flame, adsorption, long-chain organic compounds, solid decomposition and detonation of solids.

Gassendi, Pierre

French philosopher and mathematician

b. Jan. 22, 1592, Champtercier, Provence

d. Oct. 24, 1655, Paris

Studying at Digne and Aix he was something of a prodigy, and became professor of philosophy at Aix at the age of nineteen. He gained fame (and enemies) by his unfavourable commentaries on Aristotle and he was a vigorous opponent of Descartes. Among his works were biographies of Tycho Brahe and Copernicus, and his *Syntagma Philosophiae Epicuri* (1649). He made some valuable observations on the transit of Mercury.

Gasser, Herbert Spencer

American physiologist

b. July 5, 1888, Platteville, Wis.

Educated at Wisconsin and the Johns Hopkins University, Gasser taught in the former before holding various professorships at Washington and Cornell. In 1935 he became director of the Rockefeller

Institute for Medical Research. He was associated with Erlanger in research on the nervous system and they shared the Nobel prize for medicine in 1944 for this work. With Erlanger he published *Electrical Signs of Nervous Activity* (1937). He worked also on the coagulation of blood.

Gauss, Karl Friedrich

German mathematician

b. Apr. 30, 1777, Brunswick

d. Feb. 23, 1855, Göttingen

Only the interest of the reigning duke persuaded Gauss' father, a bricklayer, that the education of his son was worthwhile. In 1807 Gauss became professor of mathematics and director of the observatory at Göttingen, and was reputed one of the greatest mathematicians in Europe. He calculated the orbits of Ceres and Pallas by a new method and was the discoverer of the famous theorem in the mathematics of electricity which is named after him. With Weber he constructed an electromagnetic telegraph by which messages were sent one and a quarter miles, and they also designed two magnetometers. The unit of magnetic field has been named the gauss.



KARL FRIEDRICH GAUSS has been called the greatest mathematical brain of all time.

GAY-LUSSAC

In pure mathematics his work established the independence of that branch. From work on the Fermat numbers he founded modern number theory; he devised the method of least squares; first studied the convergence of infinite series; did basic work on the theory of surfaces; and he conceived the first ideas of non-Euclidean geometry, analytic functions and topology.

Gay-Lussac, Joseph Louis

French chemist and physicist

b. Dec. 6, 1778, St. Léonard, Haute-Vienne
d. May 9, 1850, Paris

Educated at Paris, Gay-Lussac became assistant to Berthollet and Fourcroy, and later professor of chemistry at the École Polytechnique. In 1832 he succeeded Fourcroy as professor of general chemistry at the Jardin des Plantes. He discovered the law of expansion of gases by heat in 1802. With Thenard he investigated the alkalis and discovered the presence of hydrogen in them, and discovered also sodium and potassium peroxides. They succeeded in isolating boron. Other of Gay-Lussac's chemical researches included studies of fermentation, prussic acid and the composition of water. One of his most famous contributions to scientific knowledge was his law of combining volumes of gases, enunciated in 1809. He made two balloon ascents to investigate terrestrial magnetism.

Geber or Jabir ibn Hayyan

Arab chemist

b. c. 721, Tus, nr. Meshed

d. c. 813 (?)

Probably a member of the south Arabian tribe Al-Azd, Geber studied under Harbi al-Himyari. One of the earliest experimenters, he was the first to describe the preparation of nitric acid, and other fundamental processes such as distillation, cupellation and the purification of metals. Much of his work is confused and overlaid with superstition and it is difficult to sort out his work from additions due to others. His personal life was bound up in the court intrigues of the period, his father being executed for political plotting. The

identification of Jabir with Geber, the author of the *Summa Perfectionis* (c.1100) and the other books on chemistry, astronomy, and geometry which go under his name, is open to doubt.

Geddes, Sir Patrick

Scottish biologist and sociologist

b. Oct. 20, 1854, Perth

d. Apr. 17, 1932, Collège des Écossais, Montpellier

A pupil of Huxley, Geddes was influenced by the work of Darwin and its application to society, and by the thought of Lamarck, Spencer and Bergson. He was professor of botany at Dundee (1883-1920), professor of sociology at Bombay, and director of the Scots College at Montpellier. He strove to effect a synthesis of evolution and morality, and of biology and history and sociology. In later years his interests became more sociological, and he was a pioneer in town and regional planning; social, academic and economic reform engaged his attention and he developed summer schools and British Halls of Residence at French Universities. He joined with J. A. Thomson in the writing of several well-known books on evolution and sex.

Gegenbaur, Carl

German anatomist

b. Aug. 21, 1826, Würzburg

d. 1903, Heidelberg

Educated at Würzburg, Gegenbaur became professor of anatomy at Jena in 1855 and in 1873 at Heidelberg. His work emphasised the importance of comparative anatomy, and his researches on fishes strongly supported Huxley in the refutation of the theory of the origin of the skull from expanded vertebrae. He was one of the strongest continental advocates of evolution. From his work on embryology he stated in 1861 that all eggs are simple cells. Schwann in 1838 having indicated this probable conclusion.

Geiger, Hans

German physicist

b. Sept. 30, 1882, Neustadt-an-der-Haardt.

After holding appointments in Manchester,

Berlin, Kiel and Tübingen, in 1925 Geiger went to the Berlin Technical Institute. He is noted for his work on radioactivity, atomic theory and cosmic rays, in the course of which he invented a counter for beta ray or cosmic ray particles. This took the form of an ionisation chamber; in conjunction with Müller and Rutherford he devised other types also.

Geikie, Sir Archibald

Scottish geologist

b. Dec. 28, 1835, Edinburgh

d. Nov. 10, 1924, Haslemere, Surrey

Educated at Edinburgh, Geikie became assistant to Murchison on the geological survey of Scotland. He did original work on glaciation in Scotland and his study of the geology of his own country earned for him the Murchison professorship of geology at Edinburgh. He was elected F.R.S. in 1865. Later he became director-general of the Geological Survey of the United Kingdom, and he did much to encourage microscopic petrography. Later travel made him an expert on volcanic geology. He was president of the British Association in 1892 and of the Royal Society in 1909, and wrote several standard geological text-books, including *Text-book of Geology* (1882).

Geikie, James

Scottish geologist

b. Aug. 23, 1839, Edinburgh

d. Mar. 1, 1915, Edinburgh

James Geikie succeeded his brother Archibald as professor of geology at Edinburgh where he had been educated. He was elected F.R.S. in 1875. In his famous book, *The Great Ice Age* (1894), he was the first to suggest multiple glaciation, an idea which though not well received is now clearly established.

Geitel, Hans Friedrich

German physicist

b. July 16, 1855, Brunswick

d. Aug. 15, 1923, Wolfenbüttel

Professor at the Brunswick Technical Institute, Geitel is known for his collaboration with Elster in the invention of the first workable photoelectric cell and photo-

meter, and a Tesla transformer. They did much work on electrical conduction and ionisation in gases (see Elster). He is the author of several books.

Genth, Frederick Augustus

American mineralogist

b. 1820, Wächtersbach nr. Hanau

d. 1893

Educated at Giessen and Marburg, Genth went to America in 1848 and became professor of chemistry and mineralogy at Pennsylvania (1872). He is famous for his discovery and investigation of the cobalt-ammonium compounds, and for the discovery of twenty-four new minerals.

Geoffroy Saint-Hilaire, Étienne

French naturalist

b. Apr. 15, 1772, Étapennes, Seine-et-Oise

d. June 19, 1844, Paris

After studying at Paris under Brisson, Geoffroy entered the church but his interest in science prevailed. He was instrumental in saving the staff of his college from the revolutionaries. In 1793 he became professor of zoology in the new museum of natural history, and meeting Cuvier, collaborated with him in the production of several memoirs. He then for the first time conceived his idea of the 'unity of organic composition', an idea destined to be the source of a lifelong argument between Cuvier and him. This idea was that all animals are formed of the same elements, in the same number and with the same connections. As a consequence of this he did not believe in the modification of existing species. In 1840 Geoffroy became blind and paralysed. His son Isidore (1805-61) continued his work.

Gerard, John

English herbalist and surgeon

b. 1545, Nantwich, Cheshire

d. Feb. 1612, London

From the trade of gardening Gerard turned to that of barber-surgeon, in which connection he rose to be master of the company. His only claim to fame lies in his *Herball* published in 1597, which enjoyed considerable success. Little of it was his own work, it being largely based on

GERHARDT

Dodoens' *Stirpium Historiae Pemptades* (1583).

Gerhardt, Charles Frédéric
French chemist

b. Aug. 21, 1816, Strasbourg

d. Aug. 19, 1856, Strasbourg

After studying under Liebig, Gerhardt became in 1844 professor of chemistry at Montpellier and in 1855 at Strasbourg. He carried out fundamental research in organic chemistry but his rather outspoken criticisms of his fellow scientists made him unpopular. His theories of homologous series and of types disagreed with those in current use, but it was shown eventually that he was right (a year before his death). For a time he worked in Paris with Laurent who also was not recognised by his contemporaries.

Gesner, Konrad von

German-Swiss botanist and zoologist

b. 1516, Zürich

d. Dec. 13, 1565, Zürich

After studying at Strasbourg, Bourges and Paris, Gesner became a schoolmaster at Zürich. He later studied medicine at Basle and rose to be professor of Greek at Lausanne and of philosophy at Zurich. His famous book *Historia Animalium* (1550-87) is regarded as the foundation of zoology as a science, and he did notable work in botany also. He is remarkable in being one of the first, if not the first, lover of mountaineering, and left a unique description of Mt. Pilatus (Lucerne). Gesner's early death was due to plague.

Giauque, William Francis

American chemist

b. May 12, 1895, Niagara Falls, Ontario

Educated at California and Columbia, Giauque became professor of chemistry at the former in 1934. He is famous for his discovery, with Johnston, of oxygen isotopes, and for his adiabatic demagnetisation method of producing temperatures within less than a degree of zero absolute. For this work, which has had important bearing on the study of the Third Law of Thermodynamics, he gained the Nobel Prize for Chemistry in 1949.

Gibbs, Josiah Willard

American mathematical physicist

b. Feb. 11, 1839, New Haven, Conn.

d. Apr. 28, 1903, New Haven

Educated at Yale, Paris, Berlin and Heidelberg, Gibbs was professor of mathematical physics at Yale 1871-1903. In addition to producing a great deal of work on mathematics (vector analysis, etc.) he is regarded as one of the founders of physical chemistry. His most important work was *On the Equilibrium of Heterogeneous Substances* (1876, 1878) and he is also famous for his work on the *phase rule* ($P + F = C + 2$), invaluable in the handling of heterogeneous equilibria. He was awarded the Copley medal in 1901.

Giesel, Friedrich O.

German chemist

b. 1852

d. Nov. 14, 1927, Brunswick

An industrial chemist at a quinine works, Giesel prepared large quantities of radioactive minerals and in 1904 discovered the radioactive element *emanium* (actinium-X), which is very closely related to actinium.

Gilbert, Grove Karl

American geologist

b. May 6, 1843, Rochester, N.Y.

d. May 1, 1918, Jackson, Mich.

Educated at Rochester, Gilbert was responsible with Powell and others for the first geological reconnaissance of the western United States in the late 19th century, and his study of the Henry Mountains of Utah is a classic. In this he was the first to notice 'pediments'. He stated the law of unequal slopes, relating to the denudation of a ridge between two valleys, and he linked up the precession of the equinoxes with the rate of sedimentary deposit in Colorado, thus giving a remarkable estimate of geological time.

Gilbert, Sir Joseph Henry

English chemist

b. Aug. 1, 1817, Hull

d. Dec. 23, 1901, Harpenden, Herts.

After studying in Glasgow and London, Gilbert finally went to Giessen under Liebig, and in 1884 became professor of

rural economy at Oxford. His name is associated with that of J. B. Lawes in the establishment of the Rothamsted experimental station for agriculture, and he is particularly noted for his work on nitrogen fertilisers as opposed to the mineral type of Liebig. He became an F.R.S. in 1860.

Gilbert, William

English physician

b. May 24, 1544, Colchester

d. Dec. 10, 1603, Colchester

After studying medicine at Cambridge, Gilbert became physician to Queen Elizabeth. Known as the 'father of magnetism', he was the first to experiment with lodestones in a scientific way, discovering the simple laws of attraction and repulsion between poles, and the phenomena of dip, etc. He recognised that the earth acted as a great magnet. He experimented also with static electricity and was responsible for the introduction into science of the words *electricity*, *electrical attraction*, *electrical force* and *magnetic pole*. A follower of Copernicus, he realised that the fixed stars are at different distances from the earth. The *gilbert*, unit of magneto-motive power, is named from him ($4\pi/10$ ampere-turns). His work *De magnete, magneticisque corporibus, et de magno magnete tellure* (1600) has been regarded as the first modern scientific treatise published in England. There is a translation by the Gilbert Club (1900).

Gill, Sir David

Scottish astronomer

b. June 12, 1843, Aberdeenshire

d. Jan. 24, 1914, London

Educated at Aberdeen, Gill built a private observatory there. In 1879 he became Astronomer Royal at the Cape of Good Hope; he charted the southern heavens photographically, and used the heliometer to measure solar and stellar parallaxes.

Girard, Albert

Dutch mathematician

b. 1595, Lorraine

d. 1632

In 1626 Girard published a book on trigonometry in which the contractions

sin, *tan* and *sec* are used for the first time. In 1629 he followed with a book on algebra containing the first use of brackets, the statement that the number of roots of an equation is equal to its degree, and a recognition of imaginary roots.

Gladstone, John Hall

English chemist

b. Mar. 7, 1827, Hackney, London

d. Oct. 6, 1902, London

Educated at London and Giessen, Gladstone became lecturer in chemistry at St. Thomas's Hospital and later, in 1874, professor of chemistry at the Royal Institution. He was elected F.R.S. in 1853. He was noted for his work on refraction, in which, with Dale, he established the law that where μ is the refractive index of a transparent gas, $(\mu-1)$ is proportional to the density of the gas.

Glaisher, James

English meteorologist

b. Apr. 7, 1809, Rotherhithe

d. Feb. 7, 1903, Croydon

First surveyor and then an assistant and later chief meteorologist at Greenwich, Glaisher was the founder of the Meteorological Society. He became an F.R.S. in 1849. He made a large number of balloon ascents, on one occasion reaching 37,000 ft. He wrote several books on scientific subjects, and produced dew-point tables which were of great value.

Glauber, Johann Rudolph

German chemist

b. 1604, Karlstadt, Bavaria

d. 1668, Amsterdam

One of the first to have clear ideas about the formation of salts from bases by the action of acids, Glauber discovered sodium sulphate (Glauber's salt) and he noticed the peculiar precipitates known as chemical gardens. He is credited with the discovery of hydrochloric acid.

Gmelin, Leopold

German chemist

b. Aug. 2, 1788, Göttingen

d. Apr. 13, 1853, Heidelberg

One of a family of scientists, after studying

GODLEE

medicine and chemistry at Göttingen, Tübingen and Vienna, Gmelin became professor of chemistry at Heidelberg and discovered potassium ferricyanide (Gmelin's salt) in 1822, and other organic substances. He was responsible in 1848 for the introduction of the terms *ester* and *ketone*. His *Handbuch der anorganischen Chemie* (1819) remains in its revised editions the standard reference book on inorganic chemistry. Gmelin's test is for the presence of bile pigments.

Godlee, Sir Rickman John

English surgeon

b. 1849, London

d. Apr. 20, 1925, Whitchurch, Shropshire

A nephew of Lister and also his biographer, in 1884 Godlee was the first to remove a tumour of the brain by a surgical operation. He was president of the Royal College of Surgeons (1911-13) and of the Royal College of Medicine (1916-18).

Goldschmidt, Hans

German chemist

b. Jan. 18, 1861, Berlin

d. May 20, 1923, Baden-Baden

Goldschmidt invented the aluminothermic or thermite process named after him, which consists of the reduction of metallic oxides, using finely divided aluminium powder fired by magnesium ribbon. The mixture is used in incendiary bombs; and the high temperatures attained (3000°C.) allows a Thermit mixture of iron oxide and aluminium to be used in welding.

Goldschmidt, Richard Benedikt

German-American biologist

b. Apr. 12, 1878, Frankfurt-on-Main

In 1921 Goldschmidt left a professorship in Munich to become biological director of the Kaiser-Wilhelm Institute, Berlin; from 1924-26 he was at Tokio University, and in 1936 became professor of zoology at California University. He is an authority on heredity, and the conductor of an important series of experiments on X-chromosomes, using butterflies. He has advanced the theory that the serial pattern of the chromosomes and the chemical configuration of the chromosome molecule are deci-

sive factors in inheritance, rather than the qualities of the individual genes. Among his books are *Die Lehre von der Vererbung* (1927), *Die Sexuellen Zwischenstufen* (1931), *Physiological Genetics* (1938), and *The Material Basis of Evolution* (1940).

Goldstein, Eugen

German physicist

b. Sept. 5, 1850, Gleiwitz, Silesia

d. Dec. 25, 1931, Berlin

Educated at Berlin, Goldstein worked as a physicist at the Berlin Observatory. In 1876 he was the first to see that cathode rays threw a shadow and were emitted at right angles to the surface. In 1886 he discovered what he called 'canal rays', later shown to be positively charged particles of atomic mass, emitted from the cathode in the direction opposite to cathode rays.

Golgi, Camillo

Italian cytologist

b. July 7, 1843, Corteno, Lombardy

d. Jan. 21, 1926, Pavia

A professor of pathology at Pavia, Golgi discovered the 'Golgi' bodies in animal cells. These bodies surround the centrosome in the cell and show an affinity for metallic salts (which led to their discovery). This method of introducing metallic salts into cells was originated by Golgi in 1873, and since these salts are readily visible under the microscope, a new field of research in cell structure was revealed. Golgi applied his method to the central nervous system and it has since been used for sense organs, muscles and glands. He shared with Ramón y Cajal the Nobel prize for medicine in 1906.

Gomberg, Moses

American chemist

b. 1866, Elisabetgrad; d. 1947

Going to America in his youth, Gomberg was educated at Michigan, Munich and Heidelberg, and became professor of chemistry at the first named (1904-36). He is famous as the discoverer of trivalent carbon and has won many honours in chemistry. He has also done much work on triphenylmethyl and its derivatives, and on free radicals and tautomerism.

Goodricke, John

English astronomer

b. Sept. 17, 1764, Groningen*d.* Apr. 20, 1786, York

The first to make a careful study of the variability of the star Algol, in 1782 Goodricke suggested that this was caused by a dark body revolving round a bright one and partially eclipsing it. He was awarded the Copley medal in 1783 for his researches on variable stars, and became an F.R.S. in 1786.

Goodyear, Charles

American inventor

b. Dec. 29, 1800, New Haven, Conn.*d.* July 1, 1860, New York

While a clerk in a hardware store, Goodyear began in 1834 to experiment on the treatment of rubber with sulphur and so invented vulcanizing in 1844. This led to the production of the well-known tyres named after him, and was of the utmost importance in the development of the motor car. His experimental methods were largely based on trial and error and he is said to have performed about ten thousand experiments before he succeeded in his objects. He is yet another example of an inventor struggling against financial adversity to achieve success, and was at one time imprisoned for debt.

Gould, Benjamin Apthorp

American astronomer

b. Sept. 27, 1824, Boston, Mass.*d.* Nov. 26, 1896, Cambridge, Mass.

Educated at Harvard, and under Gauss at Göttingen, Gould played an important part in the survey of the U.S. coast and in work on standard stars used in navigational astronomy. The founder of the Argentine Observatory at Córdoba, he compiled several monumental star catalogues, e.g., *Uranometria Argentina* (1879). His death was due to an accidental fall on a staircase.

Graaf, Regnier de

Dutch biologist

b. July 30, 1641, Schoonhoven, Holland*d.* Aug. 17, 1673, Delft

Educated at Louvain, Utrecht, Leyden and Angers, Graaf practised medicine at

Delft. He is noted for his discovery of the Graafian follicles, small globular transparent vesicles in mammalian ovaries. Each follicle contains one ovum. They were originally thought to be the actual ova. Graaf also improved and developed methods of preserving specimens in museums by injecting solidifying substances, and investigated the pancreatic juice.

Graebe, Karl

German chemist

b. Feb. 24, 1841, Frankfort-on-Main*d.* Jan. 19, 1927, Frankfort-on-Main

Professor of chemistry in Geneva, Graebe was famous for his synthesis of organic compounds. He was associated with Liebermann in the first synthesis of alizarin from anthraquinone (1869).

Graham, Thomas

Scottish chemist

b. Dec. 21, 1805, Glasgow*d.* Sept. 16, 1869, London

After studying under Thomson at Glasgow, Graham became professor of chemistry at University College, London, in 1837, but resigned in 1855 to become Master of the Mint. Elected an F.R.S. in 1836 he was one of the founders of physical chemistry and conducted many famous researches on the absorption of gases, osmosis, diffusion, etc. He was the discoverer of the properties of colloids and their separation by dialysis, and of the law named after him, which states that at equal temperatures and pressures the velocities of diffusion of different gases are inversely proportional to the square roots of the densities of the gases. He also devised a compensated pendulum having as a bob a reservoir containing mercury.

Gram, Hans Christian Joachim

Danish physician

b. 1853*d.* Nov. 14, 1938

A bacteriologist at Copenhagen, Gram devised a method, named after him, for staining bacteria with methyl violet, iodine and acetone or ethyl alcohol. This gave rise to the Gram-positive and Gram-

GRASSI

negative tests. Bacteria which do not stain are termed Gram-negative.

Grassi, Giovanni Battista
Italian zoologist

b. Mar. 27, 1854, Rovellasca

d. May 4, 1925, Rome

Educated at Pavia, Heidelberg and Würzburg, Grassi became professor of zoology at Catania, and of comparative anatomy at Rome in 1895. He conducted important researches on intestinal worms, eels, termites and malaria. His discovery of transitional types of eel in the Straits of Messina (1896) led to the solution of the problem of eel migration (see J. Schmidt).

Gray, Stephen
English physicist

d. Feb. 25, 1736

A Charterhouse pensioner who experimented in static electricity, Gray was one of the first to perform simple frictional experiments showing conduction. He proved that electrification is a surface phenomenon, without appreciating the fact.

Green, George
English mathematician

b. July 14, 1793, Sneinton, Notts.

d. Mar. 31, 1841, Sneinton, Notts.

Practically self-educated in mathematics, Green applied his knowledge to electrical problems and introduced the word *potential* into electricity. He developed many theorems in electrostatics and magnetism which were to inspire Kelvin's work. He went to Cambridge later in life (1833) and became fourth wrangler.

Gregor, William (Rev.)
English chemist

b. Dec. 25, 1761, Trewarthenick, Cornwall

d. July 11, 1817, Creed, Cornwall

Educated for the church at Bristol and Cambridge, Gregor was a minister in Devonshire and Cornwall. He became famous for his analyses of local minerals, which included the sand now known as *ilmenite* (FeTiO_3). In this he discovered titanium, but his discovery was largely unnoticed and soon forgotten.

Gregory, David
Scottish mathematician

b. June 24, 1661, Aberdeen

d. Oct. 10, 1708, Maidenhead, Berks.

A nephew of James Gregory, David Gregory was professor of mathematics at Edinburgh in 1684 and at Oxford in 1691. In his works on geometry and optics he first put forward the suggestion of the possibility of making an achromatic combination of lenses.

Gregory, James

Scottish mathematician

b. Nov. 1638, Drumoak, Aberdeenshire

d. Oct. 1675, Edinburgh

Educated at Marischal College, Gregory became professor of mathematics at St. Andrews in 1688, and at Edinburgh in 1674. He was an F.R.S. He was probably the first to distinguish between convergent and divergent series, and was the discoverer of the series from which π can be calculated:—

$$a = \tan a - \frac{1}{3} \tan^3 a + \frac{1}{5} \tan^5 a - \dots$$

He constructed the famous Gregorian reflecting telescope which has an eyepiece piercing the reflector and a small concave mirror directing the rays into it. This was described in his *Optica Promota* (1663).

Grew, Nehemiah

English botanist

b. 1641, Warwickshire

d. Mar. 25, 1712, London

Educated at Cambridge and Leyden, Grew became a doctor in London. One of the earliest to become F.R.S., he was secretary of the society in 1677. He was an early microscopist and devoted his time to vegetable anatomy, producing a fine *Anatomy of Plants* in 1682. He observed the porous nature of plant tissue (cell structure) and correctly guessed that the flowers are the sexual organs. He was the first to use the expression 'comparative anatomy' and wrote a remarkable treatise on the *Comparative Anatomy of Stomachs and Guts* (1681).

Grignard, François Auguste Victor
French chemist

b. May 6, 1871, Cherbourg

d. Dec. 25, 1935, Lyons

Educated at Cherbourg and Lyons, Grignard became interested in organic chemistry; he was professor first at Nancy and then in 1914 at Lyons. His fame rests on his discovery of the organo-magnesium compounds, made by dissolving dry magnesium powder in dry solutions of alkyl bromides or iodides in ether. This led to the introduction of the 'Grignard reaction', a fruitful method of synthesis in organic chemistry. Part of the work was due to his teacher, P. A. Barbier. With Sabatier in 1912 he was awarded the Nobel prize for chemistry.

Grimaldi, Francesco Maria

Italian physicist

b. April 2, 1618, Bologna

d. Dec. 28, 1663, Bologna

Professor of mathematics at Bologna, Grimaldi was the discoverer of the diffraction of light; he studied also interference and prismatic dispersion. His *Physico-mathesis de lumine* (1665) contained the first sketch of a wave theory of light, and underlay Newton's work on optics.

Grosse, Aristid V.

American chemist

b. Jan. 4, 1905, Riga

Educated at Berlin, Grosse went to the U.S.A. in 1930 and in 1940 became a research fellow in the department of physics at Columbia University. In 1927 he isolated element 91, protactinium, and with Nier, Booth and Dunning in 1940 he obtained experimental verification of uranium-235 fission by slow neutrons, preparing the way for the atomic bomb.

Grosseteste, Robert

English scholar

b. c. 1175, Stradbroke, Suffolk

d. Oct. 9, 1253, Buckden, nr. Huntingdon

Educated at Oxford and Paris, Grosseteste lectured at the first-named before becoming Bishop of Lincoln. In his theological life he quarrelled with the Pope and was excommunicated for his refusal to accept the Pope's nephew as a nominee for a canonry at Lincoln. Though most famous for his linguistic abilities and his mastery of logic, he was also one of the earliest naturalists

and stressed the importance of experiment. He wrote on many subjects in natural science including sound, motion, problems of light and heat, etc.

Grove, Sir William Robert

British physicist

b. July 11, 1811, Swansea

d. Aug. 1, 1896, London

Educated at Oxford, Grove trained for the bar but ill-health caused him to turn to science and he eventually became professor of experimental philosophy at London Institution (1840-47) and a fellow of the Royal Society. He is known for his researches on electrolytic decomposition and in particular for his invention of a new type of cell, named after him. He was the first to demonstrate the dissociation of water. Later in life he returned to the law, becoming in 1880 a judge of the Queen's Bench, and a Privy Councillor in 1887.

Guericke, Otto von

German physicist

b. Nov. 20, 1602, Magdeburg

d. May 11, 1686, Hamburg

After studying law at Jena and mathematics at Leyden, Guericke returned to his native city where he became burgomaster. In 1654 he invented the air-pump, and he performed the famous experiment to illustrate air-pressure, with thirty horses pulling against each other on hollow hemispherical copper containers which had been placed together and exhausted of air. In 1672 he published a work entitled *De Vacuo Spatio*. He was also the inventor of the toy hygrometer in which a figure appears and disappears according to changes in the humidity of the atmosphere, and he invented the first electrical machine, in the form of a ball of sulphur which became electrified when rotated against the friction of the hand. With this he was able to show that like charges repel each other.

Guettard, Jean Étienne

French geologist

b. Sept. 22, 1715, Étampes

d. Jan. 7, 1786, Paris

After studying medicine at Paris, Guettard

GUILLAUME

became keeper of the natural history collections of the Duke of Orleans. In 1770 he made careful observations on weathering by wind and rain. He inferred the rise of the land and sea floor to compensate for the loss by weathering (isostasy) and prepared the first geological map.

Guillaume, Charles Édouard

Swiss physicist

b. Feb. 15, 1861, Fleurier, Switz.

d. June 13, 1938, Paris

Educated at Neuchâtel, Guillaume became director of the Bureau of International Weights and Measures (Sèvres). He is famous for his invention of 'Invar', the nickel-steel alloy which is practically free from expansion (coefficient of linear expansion, 0.0000008). This is used for standard measures and precision instruments. He was awarded the Nobel prize for physics in 1920 for his work on nickel-steel alloys.

Guldberg, Cato Maximilian

Norwegian mathematician

b. 1836, Christiania (Oslo)

d. 1902, Christiania

A professor of applied mathematics at the University of Christiania where he was educated, Guldberg made important researches on thermodynamics and chemical equilibrium, and collaborated with his brother-in-law Waage in formulating

the law of mass action (1864): the velocity of a homogeneous chemical reaction is proportional to the product of the concentrations of the reactants.

Gullstrand, Allvar

Swedish ophthalmologist

b. June 5, 1862, Landskrona

d. Aug. 30, 1930, Uppsala

Professor of physiological and physical optics at Uppsala, Gullstrand was an authority on the eye and its dioptrics and was responsible for new ideas concerning the formation of optical images. He was awarded the Nobel prize for physiology and medicine in 1911 for this work. He was responsible for improvements in spectacle lenses, and, in 1911, in the slit lamp, a valuable diagnostic appliance.

Gunter, Edmund

English mathematician and astronomer

b. 1581, Hertfordshire

d. Dec. 10, 1626, London

Educated at Oxford, Gunter became professor of astronomy at Gresham College, London, in 1619. In 1620 he introduced the terms *cosine* and *cotangent* into trigonometry. He invented the surveyor's chain named after him (66 ft. divided into 100 links). He also invented the logarithmic scale which is the principle of the slide-rule, though Oughtred was probably the first with this invention.

H

Haber, Fritz

German chemist

b. Dec. 9, 1868, Breslau

d. Jan. 21, 1934, Basle

Educated at Berlin and Heidelberg, Haber became professor of chemistry at Karlsruhe and later at Berlin. He is famous for his investigations on the synthesis of ammonia from hydrogen and nitrogen catalytically at 500° C. and high pressures (*Haber process*; see also Bosch); and for his work on electrochemical problems. He was awarded the 1918 Nobel prize for chemistry.

Hadfield, Sir Robert Abbott

English metallurgist

b. Nov. 29, 1859, Sheffield

d. 1940

Educated at Sheffield, Hadfield became interested in metallurgy and rose to be chairman of Hadfield's Ltd. Elected F.R.S. in 1908, he wrote a standard work on his subject, *Metallurgy and its Influence on Modern Progress* (1925). He is famous as the inventor of the process for the production of manganese, silicon and stainless steel, and he also did valuable work on ferrous alloys, in particular, low hysteresis steel.

Hadley, John

English astronomer

b. Apr. 16, 1682

d. Feb. 14, 1744, East Barnet, Herts.

Hadley invented the sextant, used for measuring the angular altitude of heavenly bodies for the determination of position at sea. His original name for it was the octant; he also constructed a quadrant, named after him, and one of the first practical reflecting telescopes.

Haeckel, Ernst Heinrich

German biologist and natural philosopher

b. Feb. 16, 1834, Potsdam

d. Aug. 8, 1919, Jena

After studying at Berlin, Würzburg and Vienna, Haeckel became professor of zoology at Jena (1865-1908), and made several scientific expeditions. An enthusiastic supporter of Darwin's theories he was prone to choose his facts to suit his monistic philosophical theories. Nevertheless he made solid contributions to biological knowledge in his studies of radiolaria, sponges and the medusae. The monograph on radiolaria (1862) was based on the material of the *Challenger* expedition. He separated the animal kingdom into unicellular and multicellular organisms, a generalisation of great importance, and formulated the principle that the development of the individual reflects that of the species.

Hahn, Otto

German physical chemist

b. Mar. 8, 1879, Frankfurt-on-Main

Hahn studied at Frankfurt, Marburg and Munich and for a time assisted Ramsay in London and Rutherford at McGill. He taught in Berlin, went in 1912 to the Kaiser-Wilhelm Institute for Chemistry, and became its director in 1928. He was Nobel laureate in chemistry for 1944, and in 1946 became president of the Max Planck Institute, Göttingen. With Meitner in 1917 he discovered protactinium, a radioactive element, and in 1935 obtained evidence of another four elements corresponding to atomic numbers 93, 94, 95 and 96. In 1938 with Strassmann he obtained experimental evidence of nuclear fission in uranium by bombardment with neutrons. His distinguished work has contributed to many important advances in the study of radioactivity and nuclear physics.

Hahnemann, Samuel Christian Friedrich

German physician

b. Apr. 10, 1755, Meissen, Saxony

d. July 2, 1843, Paris

After studying medicine at Leipzig and

HALDANE

Vienna, Hahnemann practised in the former town. His observations on quinine led him to the idea that the effects of drugs on healthy subjects are similar to those of the disorders which they cure (1796). He thus was the founder of homoeopathy, an idea so ill-received at the time that he was obliged to leave Leipzig and settle elsewhere. His teaching is contained in his *Organon der Rationellen Heilkunde* (1810). See Bradford, *Hahnemann's Life and Letters* (1895).

Haldane, John Burdon Sanderson
English physiologist

b. Nov. 5, 1892

Educated at Oxford, Haldane worked as a biochemist at Cambridge and finally became professor of genetics at University College, London (1937). He was elected F.R.S. in 1932 and has done much work on physiology and biochemistry and also has written many books connected with the philosophy of science.

Hale, George Ellery

American astronomer

b. June 29, 1868, Chicago

d. Feb. 21, 1938, Pasadena

Educated at the Massachusetts Institute of

Technology, Hale became professor of astrophysics at Chicago and was director of the Yerkes Observatory up to 1905. He organised the Mt. Wilson Observatory in 1904 and was director there up to 1923. With Pease in 1920 he was the first to measure the diameter of a star (alpha Orionis) with the interferometer. At Harvard College Observatory and later at Chicago he invented (as did also Deslandres about the same time) the spectroheliograph, which has done so much to extend our knowledge of the solar atmosphere. He proved that the sun's magnetic and geographical poles, like the earth's, do not coincide. He wrote several books.

Hales, Stephen

English botanist and chemist

b. Sept. 1677, Bekesbourne, Kent

d. Jan. 4, 1761, Teddington, Middlesex

After studying at Oxford, Hales became vicar of Teddington, where he remained for 52 years, refusing preferment as he wished to devote himself to scientific experiment. He was awarded the Copley medal in 1753 having been elected F.R.S. in 1717. Hales collected, by means of his new pneumatic trough, gases from coal, red lead and saltpetre, iron filings and dilute sulphuric acid and other heterogeneous substances, but thought all the gases so collected were air, as he made no qualitative tests and did not doubt that air was an element. He invented many devices connected with food-preservation, sea-water purification, ventilation and other matters, and did not disdain the consideration of small problems such as the introduction of a cup into a pie to prevent the crust falling. In conjunction with Littlewood, the shipwright, he was one of the first to aerate dirty water with a view to purifying it. His *Vegetable Statics* (1727) was the first textbook in plant physiology, and it is to him that we owe the first suggestion that plants obtain part of their nourishment from air.

Hall, Asaph

American astronomer

b. Oct. 15, 1829, Goshen, Conn.

d. Nov. 22, 1907, Annapolis, Md.



REV. STEPHEN HALES

A carpenter by trade, Hall became interested in mathematics and so in astronomy, in which connection he became assistant to Bond. He later became professor of mathematics at the Naval Observatory, Washington, where he remained from 1862 to 1891. It was here in 1877 that he discovered the two satellites of Mars, Deimos and Phobos.

Hall, Charles Martin

American chemist

b. Dec. 6, 1863, Thompson, Ohio

d. Dec. 27, 1914, Daytona, Florida

Educated at Oberlin College, Ohio, while there Hall discovered in 1886 the modern method of extracting aluminium by the electrolysis of bauxite. Up to this time the metal had been an expensive curiosity. He became vice-president of the Aluminium Co. of America.

Hall, Marshall

English physiologist

b. Feb. 18, 1790, Basford, Notts.

d. Aug. 11, 1857, Brighton

Educated at Edinburgh, Paris and Göttingen, Hall became a physician in Nottingham and he is renowned for his discovery of reflex action, as announced in *Reflex Functions of the Medulla Oblongata and Medulla Spinalis* (1833). This theory was strongly criticised at the time but has since gained universal acceptance. From a study of cold-blooded vertebrates Hall showed that the nervous centres for many of these reflex actions lie in the spinal cord. His humanitarian interests are reflected in his obtaining the abolition of flogging in the army. He introduced a method of artificial respiration named after him, which was used successfully for many years, and he devised treatment for epilepsy.

Haller, Albrecht von

Swiss anatomist and physiologist

b. Oct. 16, 1708, Berne

d. Dec. 17, 1777, Berne

After study at Tübingen and Leyden, Haller became professor of anatomy and surgery at Göttingen. He was one of the most versatile of men, being a novelist as well as scientist and philosopher. His

historical works on science were of great importance, but the *Elementa Physiologiae Corporis Humani* (8 vols., 1757-66) was his greatest work containing as it does his doctrine of irritability. This specifies the contraction of living muscle fibres under stimulation; his views on embryology, however, were unsound.

Halley, Edmund

English mathematician and astronomer

b. Oct. 29, 1656, London

d. Jan. 14, 1742, Greenwich

After leaving Oxford, Halley stayed two years (1676-78) on St. Helena cataloguing the stars of the southern hemisphere. This was the first southern star catalogue. He became professor of geometry at Oxford in 1703 and Astronomer Royal in 1719. In 1682 he described the comet which was subsequently named after him, and predicted its return in 1759. This was the first prediction of its kind that proved correct. He also made the first determination of stellar proper motion. In 1686 he published the first map of the winds on the earth's surface, and in 1715 suggested for the first time that the sea was salt because of the deposits from rivers. He was a friend of Sir Isaac Newton, and it was he who paid for the publication of the *Principia*.

Hamilton, Sir William Rowan

Scottish mathematician and astronomer

b. Aug. 4, 1805, Dublin

d. Sept. 2, 1865, Dublin

At the age of fourteen Hamilton knew thirteen languages and at seventeen was the greatest living mathematician. By 1827 he was professor of astronomy at Trinity College, Dublin, where he was educated, and Irish Astronomer Royal. His fame rests upon his invention of the calculus of quaternions, a three-dimensional algebra or geometry. He was the originator of the hodograph and gave it its name. He predicted from theoretical principles various peculiarities of conical refraction (*Theory of Systems of Rays*, 1828). His most important work, *General Methods of Dynamics* (1834-5), formulates classical mechanics on the lines since followed by quantum theory.

HANSEN

Hansen, Armauer

Norwegian bacteriologist

b. 1841

d. 1912

A physician of Bergen and the leading authority on leprosy of his time, Hansen was the discoverer of the bacillus of that disease (1879).

Hantzsch, Arthur

German organic chemist

b. Mar. 7, 1857, Dresden

d. Mar. 14, 1935, Dresden

Professor of chemistry in Leipzig, Hantzsch was noted for his work on acids, electrical conductivity (of organic compounds) and the stereochemistry of nitrogen compounds.

Harden, Sir Arthur

English chemist

b. Oct. 12, 1865, Manchester

d. June 17, 1940

Educated at Manchester and Erlangen, Harden returned to Manchester as lecturer in chemistry before going to London (1898-1930) and to the Lister Institute as professor of biochemistry. He was elected F.R.S. in 1909, and gained the Nobel prize for chemistry in 1929 (with Euler-Chelpin) for his researches on enzymes and alcoholic fermentation. He was knighted in 1936.

Hardy, Alister Clavering

English biologist

b. Feb. 10, 1896, Nottingham

Educated at Oxford, after being professor of natural history at Aberdeen Hardy became professor of zoology and comparative anatomy at Oxford in 1946. An authority on oceanography, he invented an automatic plankton recorder to make a quantitative investigation of the sea's vegetation, and also carefully investigated the life history of a herring with respect to its diet.

Hare, Robert

American chemist

b. Jan. 17, 1781, Philadelphia, Pa.

d. May, 15, 1858, Philadelphia, Pa.

Professor of chemistry at the University of Pennsylvania, Hare was famous for his

inventions in the form of new apparatus. In 1801 he devised the oxyhydrogen blow-pipe, and he is known to most students of physics by his apparatus for measuring the relative density of liquids.

Hargreaves, James

English inventor

b. 1720, nr. Blackburn

d. Apr. 22, 1778

After devising his great improvement in cotton spinning, the spinning jenny, about 1764, Hargreaves was forced by machine-breaking mobs to leave his native town and go to Nottingham. He also failed to patent his machine through selling some before applying for the patent. Nevertheless his invention marks one of the steps in cotton manufacture and in the Industrial Revolution.

Hargreaves, James

English chemist

b. 1834, Hoarstones, Pendle Forest, Lancs.

d. Apr. 4, 1915, Widnes, Lancs.

An industrial chemist, Hargreaves was a prodigious inventor who held more than 200 patents. His work included improvements in soap manufacture, the recovery of chemicals from waste (sulphur and phosphates), the manufacture of hydrochloric acid and, with Bird, the electrolytic process for making soda. His thermomotor running on gas-tar was the forerunner of the Diesel engine.

Harington, Charles Robert

English chemist

b. Aug. 1, 1897

Educated at Malvern College and Cambridge, Harington became professor of pathological chemistry at University College, London, in 1931, and was elected F.R.S. in 1931. He has done much research in biochemistry and in particular was associated with Barger in his synthesis of thyroxine (isolated by Kendall, 1915). In 1933 he published a book on *The Thyroid Gland: its Chemistry and Physiology*.

Harrison, John

English horologist and inventor

b. Mar. 28, 1693, Foulby, Yorks.

d. Mar. 24, 1776, London

Competing for the government prize for the accurate determination of longitude, Harrison in 1765 perfected the chronometer winning with it the first award of £20,000. He also invented (1726) the gridiron compensated pendulum consisting of iron and brass rods expanding in opposite directions.

Harrison, Ross Granville

American biologist

b. Jan. 13, 1870, Germantown, Phil.

Educated at the Johns Hopkins University, Harrison became professor of anatomy there. After holding a variety of high academic posts he became professor of biology at Yale in 1927, and gained worldwide recognition for his services to biology. He discovered a new method of studying cells, the hanging-drop culture method (1907), which permitted him to keep fragments of living tissue alive in suitable media and to watch them multiply. (See Carrel.) His work on regeneration of peripheral nerves and the role of the nervous system in embryonic muscle differentiation is important and authoritative.

Harvey, Sir William

English physician

b. Apr. 1, 1578, Folkestone, Kent

d. June 3, 1657, London

Educated at Cambridge and Padua under Fabricius and Galileo (1597-1601), Harvey became physician at St. Bartholomew's, and lecturer to the College of Physicians. He is famous for his discovery of the true circulation of the blood, published in his *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus* (1628). Previous physicians had known of the arterial circulation but did not understand the return of the blood to the heart, regarding the blood circulation as more in the nature of an irrigation. Harvey became physician to James I and Charles I and was present at Edgehill. The eventual success of the Parliamentarians led to his retirement from public life. See *Life* by Willis (1878).

Hatchett, Charles

English chemist

b. 1765, London

d. Feb. 10, 1847, Chelsea

A research worker and an F.R.S. (in 1797), Hatchett was an analyst of great brilliance. In 1801 he discovered the element columbium in a mineral since named columbite, though he failed to isolate the metal. The actual specimen which he analysed had been in the British Museum for many years. His giving up scientific research at a comparatively early age and going into business was a considerable loss to chemistry.

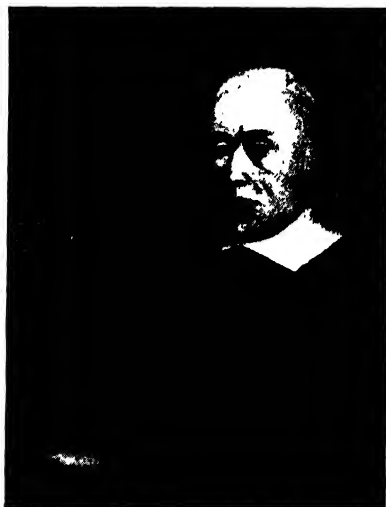
Haüy, Abbé René Just

French mineralogist

b. Feb. 28, 1743, St. Just, Oise

d. June 3, 1822, Paris

After studying theology Haüy became an abbé and for twenty-one years was a professor at the Collège de Navarre. The breaking of a piece of calcareous spar as he worked, suggested to him further experiments. As a result of these he was able to formulate a geometrical law of crystallisation, named after him, and of cardinal importance to the science of crystallography. He was noted also for his work on pyro-electricity. He was one of those saved from the revolutionaries by his pupil Geoffroy Saint-Hilaire, and was later made



WILLIAM HARVEY, "that great man".

HAWORTH

professor of mineralogy by Napoleon, but again deprived of his post at the Restoration.

Haworth, Sir Walter Norman

English chemist

b. Mar. 19, 1883, Chorley, Lancs.

d. Mar. 18, 1950, Birmingham

Educated at Manchester and Göttingen, Haworth became an F.R.S. in 1928. He was professor of chemistry at Newcastle-on-Tyne and then Birmingham (1925-48). In 1933 he succeeded in synthesising ascorbic acid (vitamin C). He shared with Karrer the 1937 Nobel prize for chemistry for this and his work on carbohydrates. He developed the Dextran complex carbohydrate substitute for blood plasma, and was an acknowledged authority on the chemical structure of sugars, his book, *The Constitution of Sugars* (1929), rapidly taking its place as a standard work. He also directed research on the gaseous diffusion separation of uranium isotopes. He was knighted in 1947, and was Vice-Principal of Birmingham University (1947-48).

Haynes, Elwood

American inventor

b. 1857

d. 1925

In addition to designing what is believed to be the oldest American motor car (1893), now in the Smithsonian Institution, Haynes also discovered many new steel alloys. In 1919 he took out a patent for stainless steel, and his alloys made use of tungsten, chromium, molybdenum and cobalt.

Heaviside, Oliver

English physicist

b. May 13, 1850, London

d. Feb. 3, 1925, Torquay

An industrial technologist, Heaviside is well-known for his research on electrical communications. He suggested the existence in the upper atmosphere of the ionised gaseous layer capable of reflecting radio-waves, and later named after him. This led to the explanation of fading in wireless signals. He made important contributions to the theory of wave propagation, to vector

analysis, operational calculus and the inductance-loaded distortionless circuit telephone. His later life was lived as a recluse though he was elected F.R.S. (1891) and accepted a Civil List Pension (1896). (See also A. E. Kennelly.)

Heilbron, Sir Ian Morris

Scottish chemist

b. Nov. 6, 1886, Glasgow

Educated at Glasgow and Leipzig, Heilbron became professor of organic chemistry at the former, going to similar posts at Liverpool (1920) and Manchester (1933) and finally becoming professor of organic chemistry at the Imperial College of Science and Technology (1938-49). He was elected F.R.S. in 1931 and has conducted many investigations into the synthesis of naturally occurring organic compounds, his work on vitamins A and D being specially noteworthy.

Heisenberg, Werner Karl

German physicist

b. Dec. 5, 1901, Duisburg, Rhenish Prussia

Educated at Munich and Göttingen and a pupil of Sommerfeld, Heisenberg became professor of physics at Leipzig in 1927, and director of the Physical Institute there. Famous for his work on the quantum theory, atomic structure and the Zeeman effect, and for his founding of quantum mechanics (1925), he evolved the principle of indeterminacy and was awarded the 1932 Nobel prize for physics. He published *Prinzipien der Quantentheorie* (1930) and other books and papers on atomic physics and cosmic rays. He was a professor at the University and director of the Planck Institute, Berlin (1942-45), and subsequently became director of the Planck Institute, Göttingen.

Helmholtz, Hermann-Ludwig Ferdinand von

German physiologist and physicist

b. Aug. 31, 1821, Potsdam

d. Sept. 8, 1894, Berlin

Educated at Berlin, Helmholtz became the first professor of anatomy at the Academy of Fine Arts in 1848. After holding various university appointments he became pro-

fessor of physics at Berlin and one of the leading scientific figures of his day. He invented a galvanometer which was a modification of the tangent galvanometer, and a resonator to magnify sound. He introduced the idea of free energy into thermodynamics, and his *Über die Erhaltung der Kraft* (1847) is a classic contribution to the idea of conservation of energy. His researches in optics led to his invention of the ophthalmometer to measure the radius of curvature of the cornea, and he invented also the phakoscope to measure the alteration in the curvature of the eye-lens during accommodation, and, most important, the ophthalmoscope, which enabled him to inspect the retina for the first time (1851). He elaborated a well-known theory of colour-vision (see also Thomas Young). His work on physiological acoustics attained equal prominence and his resonance theory of hearing is largely accepted. The fine *Sensations of Tone* can still be read with profit. One of his most important researches was his measurement of the speed of nervous impulses (120 metres/sec. in cold-blooded vertebrates), significant as the first application of ordinary physical methods to the study of the nervous system. He estimated the life of the sun on the theory, now abandoned, that its energy is due solely to contraction. His later life was devoted to research in a large number of fields, electrical, optical and dynamical. In epistemology, he opposed the conception of innate ideas and regarded all knowledge as the result of experience data.

Helmont, Jan Baptista van

Belgian chemist

b. 1577, Brussels

d. Dec. 30, 1644, Brussels

Born of a noble family, van Helmont began by studying art. He refused all academic rewards as vanity, turning to religion and then to medicine. His opinion of the current medical literature was such that he gave away his books and regretted not having burnt them. Finally taking up chemistry, he spent much time experimenting, and though he believed in transmutation, he is symbolic of the change from

alchemy to chemistry proper. He used the balance frequently in quantitative experiments, and appreciated that a metal dissolved in acid is not lost but can be recovered. He was familiar with nitric and sulphuric acids, and introduced the name *gas* (from Gk. *chaos*) to chemistry; and was the first to recognise carbon dioxide as a gas (which he named *gas sylvestre*), and, indeed, the first to distinguish any other gas from air. As the writer of a famous book on renal calculi and their crystallization from urine, he demonstrated osmosis experimentally and explained the passage of digested food through the intestinal walls as an example of it, recommending alkalis and acids as indigestion remedies. He conducted a famous experiment to show that solid material is made from water, by growing a tree from a given weight of watered earth and showing that the earth did not lose weight. Therefore, he argued, the tree came from water.

Helriegel, Hermann

German biologist

b. 1831

d. 1895

Noted for his investigations, with H. Wilfarth, of the Leguminosae, Helriegel discovered that these plants can absorb atmospheric nitrogen. This, he showed, was performed by their root nodules and he proved that the rate of absorption is proportional to the nodulation. Thus these plants can live without both ammonia and nitrates. Bacteria are the agents of this nitrogen fixation.

Henderson, George Gerald

Scottish chemist

b. Jan. 30, 1862, Glasgow

d. Sept. 28, 1942

Educated at Glasgow and Leipzig, Henderson became professor of chemistry at the former in 1919. He retired in 1937. His researches included work upon catalysis. He was elected F.R.S. in 1916.

Henderson, George Hugh

Canadian mathematical physicist

b. Dec. 8, 1892

Educated at Dalhousie and Cambridge,

HENDERSON

Henderson became professor of mathematical physics at the former university in 1924. He collaborated with S. Bateson in the design of a microphotometer for the study of pleochroic haloes in rocks. This procedure affords a determination of the age of the rock. °

Henderson, Thomas

Scottish astronomer

b. Dec. 28, 1798, Dundee

d. Nov. 23, 1844, Edinburgh

Trained as a clerk, Henderson studied astronomy in his leisure time and despite faulty eyesight was able to contribute to the progress of astronomical computation. He became Astronomer Royal at the Cape of Good Hope for a short time, ill-health causing his resignation. He was elected an F.R.S. in 1840. He became professor at Edinburgh, and the first Astronomer Royal for Scotland. In 1832 he measured the parallax of a star, alpha Centauri, but his results were not published until 1839. In the meantime Bessel had succeeded in solving the same technical problem in 1838. Henderson also observed a transit of Mercury.

Henle, Friedrich Gustav Jakob

German pathologist and anatomist

b. July 9, 1809, Furth, Franconia

d. May 13, 1885, Gottingen

After study at Heidelberg and Bonn, Henle held posts at Berlin and Zürich before going to Heidelberg (1844) to teach pathology and anatomy. From here he went to Gottingen in 1852. He published a number of monographs on a variety of biological subjects, e.g., the lacteal system, structure of the hair, the nervous system, and the formation of mucus and pus; but his most famous work is his *Handbuch der Rationellen Pathologie* (1846-52), integrating the study of physiology and pathology. In 1840 he had put forward his theory that infectious disease is conveyed by invisible forms of life.

Henry, Joseph

American physicist

b. Dec. 17, 1797, Albany, N.Y.

d. May 13, 1878, Washington

Apprenticed to a watchmaker, Henry studied science, eventually to become professor of natural philosophy at Princeton in 1832. Famous for his work on electromagnetic induction, he also did research in meteorology and acoustics. The unit of inductance is named after him. In 1829 he constructed the first electromagnetic motor, the forerunner of all future motors, and in 1842 he showed that electric discharges are oscillating. While at the Smithsonian Institution he originated the system of weather reporting.

Henry, William

English chemist

b. Dec. 12, 1775, Manchester

d. Sept. 2, 1836, Pendlebury, Manchester

Educated at Edinburgh in medicine, Henry practised as a doctor in Manchester before ill-health caused him to retire. He then devoted himself to chemistry. He became an F.R.S. in 1808 and was awarded the Copley medal in 1809. He discovered the law named after him which states that the amount of gas absorbed by a liquid is proportional to the pressure.

Hensen, Victor

German physiologist

b. 1835, Kiel

d. 1924

The founder of the particular branch of biology dealing with the whole floating fauna of the sea, Hensen invented the word *plankton* to describe this form of living substance. He did much research on its production.

Hering, Ewald

German physiologist and psychologist

b. Aug. 5, 1834, Alt-Gersdorf, Saxony

d. 1918

Lecturer in physiology at Leipzig (1862), Hering became professor there (1895), after filling chairs in Vienna and Prague. He is noted for his work on the physiology of the eye, and introduced new theories of colour vision and memory. See F. Hillebrand, *E. Hering* (1918).

Hermite, Charles

French mathematician

b. 1822

d. 1901

Well-known for his work on the theory of numbers, elliptic functions, etc., Hermite was the first to solve a 5th degree equation. He proved that the base of natural logarithms, e , is not an algebraic number.

Hero, of Alexandria

Greek mathematician and inventor
c. 80 B.C.

There is considerable doubt as to the *floruit* of Hero, or Heron as he is also known, some authorities placing him in the third century. He was at any rate an early scientist who made many simple machines, including a steam-engine and a double force-pump suitable for a fire-engine. He described also a theodolite (*dioptra*) and made suggestions for its use in surveying. In optics he showed that the angle of incidence is equal to the angle of reflection.

Herophilus

Greek anatomist
b. c. 250 B.C., Chaludon

A member of the Alexandrian school, Herophilus was the first to dissect publicly the human body, and to compare its structure with that of animals. He recognised the brain as the centre of the nervous system, which he divided into sensory and motor, and noted the difference between arteries and veins. He was responsible for the naming of the duodenum and was the first to count the pulse. He described the ventricles of the brain, the liver, spleen, and sexual organs.

Hérault, Paul Louis Toussaint

French metallurgist
b. 1863
d. 1914

Hérault invented in 1886, simultaneously with C. H. Hall, the Hérault process for extracting aluminium from cryolite electrolytically. The Hérault furnace, designed for the production of electric steel, is another of his inventions.

Herschel, Sir Frederick William

German-British astronomer
b. Nov. 15, 1738, Hanover
d. Aug. 25, 1822, Slough, Bucks.
Coming to England in 1757 as a conductor of a military band, Herschel devoted his



SIR (FREDERICK) WILLIAM HERSCHEL

leisure time to astronomy and constructed a reflecting telescope of a new pattern. This had a slightly inclined reflector, and the image was viewed directly without the usual small mirror in the tube. With a seven-foot reflector he began in 1779 to make a regular survey of the heavens, and in 1781 discovered Uranus (named by him *Georgium Sidus*). For this discovery he was granted a pension of £400 per annum. In 1789 he discovered the nearest two of the satellites of Saturn during observations of the planet's rings and rotation period. He discovered also two of the satellites of Uranus. In 1802 he had completed a catalogue of 5,000 nebulae and star clusters which he had discovered. He was helped greatly in his unremitting labour by his sister Caroline and his brother, an optical instrument maker. See J. L. E. Dreyer, *A Short Account of Sir William Herschel's Life and Works*.

Herschel, Sir John Frederick William

English astronomer
b. Mar. 7, 1792, Slough, Bucks.
d. May 11, 1871, Hawkhurst, Kent
The son of Sir William Herschel (see above), he was educated at Cambridge and

HERTWIG

continued the work of his father, discovering another 525 nebulae and clusters. He built an observatory near Cape Town to extend his observations to the southern hemisphere. In 1848 he was president of the Royal Astronomical Society and in 1856 was Master of the Mint. He was a pioneer in celestial photography, and was awarded the Copley medal in 1821. As a chemist he contributed much towards the advancement of photography, being the inventor (independently of Talbot) of photography on sensitised paper, and he introduced the terms *positive* and *negative*.

Hertwig, Oscar

German embryologist

b. Apr. 21, 1849, Friedberg, Ober-Hessen
d. Oct. 26, 1922, Berlin

After studying at Jena, Zürich and Bonn, Hertwig became professor at Jena and later at Berlin. His great contribution to embryology was his proof that only one sperm normally enters the egg in fertilisation. This he showed (with Fol) in 1879, using the gametes of a sea-urchin.

Hertz, Gustav

German physicist

b. July 22, 1887, Hamburg
d. 1950, Russia

A nephew of H. R. Hertz, Gustav Hertz was educated at Göttingen, Munich and Berlin. He became professor of physics at Halle, then at Berlin and finally director of the Siemens Research Laboratory. With Franck he was awarded the Nobel prize for physics in 1925 for his work on the effect of electron impacts on atoms.

Hertz, Heinrich Rudolf

German physicist

b. Feb. 22, 1857, Hamburg
d. Jan. 1, 1894, Bonn

After studying at Berlin, Hertz became in 1880 assistant to Helmholtz. In 1889 he succeeded Clausius at Bonn. He is famous for his discovery of Hertzian waves, electromagnetic radiation in the ether, which had been predicted by Maxwell. He showed that as regards reflection, refraction and polarisation these waves behave like light, thus again verifying Maxwell's conception of light as electromagnetic radiation.

Hess, Germain Henri

Swiss chemist

b. Aug, 1802, Geneva

d. Nov. 30, 1850, St. Petersburg

A professor of chemistry at St. Petersburg, Hess stated in 1840 the law, named after him, to the effect that the heat evolved in a reaction is constant and independent of the number of stages. Later this was seen to be a consequence of the law of conservation of energy.

Hess, Victor Francis

Austrian-American physicist

b. June 24, 1883, Waldstein, Austria,

Educated at Graz, Hess held academic appointments there and elsewhere before becoming professor of physics at Fordham University (N.Y.) in 1938. He shared with C. D. Anderson the Nobel prize for physics in 1936. He collaborated with R. W. Lawson in 1918 in a determination of the number of alpha-particles expelled by a gramme of radium, and was among the earliest investigators of cosmic rays.

Hess, Walter Rudolf

Swiss physiologist

b. Mar. 17, 1881, Frauenfeld

After being a school-teacher, Hess qualified in medicine, and in 1917 became professor of physiology and director of the Physiological Institute at Zurich. His distinguished researches on the nervous system include a formulation of the principles of automatic nerve function, and of sympathetic and parasympathetic nerve impulses. He began in 1925 researches on the brain and introduced the technique of stimulating severely localised areas by the insertion of needle electrodes, the motor reactions being recorded photographically. The destruction of localised brain tissue by electrocoagulation affords data for deducing the functions of the area concerned. For this work (pub. 1948), especially his discovery of the organiser function of the middle brain in co-ordinating the activity of internal organs, he shared the Nobel prize for medicine for 1949 with Moniz.

Hévesy, Georg von

Hungarian-Swedish chemist

b. Aug. 1, 1885, Budapest

Educated at Budapest, Berlin and Freiburg,

Hevesy became in 1926 professor of physical chemistry at Freiburg. In 1923 while working as professor at the Copenhagen Institute of Theoretical Physics he discovered, with Coster, the element hafnium. He did work on radio-isotope indication and gained the Nobel prize for chemistry in 1943 for this work, which began the important technique of isotope tracing of biological and chemical processes. The second World War drove him as a refugee to Stockholm, where he became a professor at the University.

Heymans, Corneille

French-Belgian physiologist

b. Mar. 18, 1892, Ghent

Educated at Ghent, Heymans studied in various foreign universities before returning there as professor of pharmacodynamics. With his collaborators he developed new physiological techniques, in particular *cross circulation*. In this, blood was passed from one animal into the organs of another by means of the carotid artery and jugular vein. He was awarded the Nobel prize for medicine in 1938 for his work on the sinus aorta in connection with the mechanism of breathing.

Hill, Archibald Vivian

English biochemist

b. Sept. 26, 1886, Bristol

Educated at Cambridge, Hill went to Manchester University (1920-23) and University College, London (1923-25), as professor of physiology, and in 1926 became Foulerton research professor of the Royal Society. An F.R.S. in 1918, he was awarded with Meyerhof the Nobel prize for physiology and medicine for 1922, for work on heat loss in muscle contraction. He was M.P. for Cambridge from 1940 to 1945, and took a prominent part in organising air-defence during the last war. He has conducted some remarkable experiments on oxygen consumption through muscular action, even measuring the oxygen 'used' by a cockroach.

Hill, Sir Leonard Erskine

English physiologist

b. June 2, 1866; *d.* Mar. 30, 1952

Educated at London, Hill became director of research at the St. John Clinic and Institute of Physical Medicine. He invented the kata-thermometer for measuring the cooling power of the air, and has written a number of books on his subject.

Hillebrand, William Francis

American geochemist

b. 1853, Honolulu

d. 1925

Educated at California and Cornell, Heidelberg, Strasbourg and Freiberg, Hillebrand became in 1908 chief chemist of the American Bureau of Standards. He determined the age of radioactive rocks from measurements of the percentage of the end product, lead.

Hinshelwood, Sir Cyril Norman

English chemist

b. June 19, 1897, London

Educated at Oxford, Hinshelwood was elected an F.R.S. in 1929, became professor of chemistry at Oxford in 1937, president of the Chemical Society, 1946-48, and was knighted in 1948. He is an eminent authority on chemical kinetics and has made a special study of bacterial cell-growth in the light of physical chemistry. His books include *Kinetics of Chemical Change* (1926, 4th ed. 1940), and *The Chemical Kinetics of the Bacterial Cell* (1946).

Hipparchus

Greek astronomer

b. c. 160 B.C., Nicaea, Bithynia

d. 125 B.C.

An early scientist who measured the length of a year to within six minutes, Hipparchus also calculated the inclination of the ecliptic and the precession of the equinoxes, and measured the eccentricity of the earth's orbit (solar orbit). He made a list of 1,080 fixed stars, was the first to fix the position of a place on the earth by latitude and longitude, and invented trigonometry.

Hippocrates

Greek physician

b. 460 B.C., Island of Cos

d. 357 B.C., Larissa

A Greek writer who is regarded as the

HIRST

father of medicine, inasmuch as his works (including a great many belonging to others which were wrongly attributed to him) were for long the foundation of medical and biological knowledge. He wrote books on epidemics and stressed the importance of diet. His aphorisms include the well-known 'Art is long and life is short', 'Desperate diseases need desperate remedies', and 'One man's meat is another man's poison'. His reputed scrupulous attention to professional ethics survives in the name of the medical (Hippocratic) oath.

Hirst, Edmund Langley

English chemist
b. 1898

Educated at St. Andrews, Hirst rose from a lectureship in chemistry at Durham in 1924 to the chair of organic chemistry at Bristol in 1936. In 1947 he became professor of organic chemistry at Edinburgh. He was elected F.R.S. in 1934. He has done much research work on the carbohydrates and vitamin C.

His, Wilhelm

Swiss biologist
b. July 9, 1831, Basle
d. Mar. 1, 1904, Leipzig

An important pioneer in developmental mechanics, His was professor of anatomy at Leipzig. He is noted as the introducer of the microtome which made possible the cutting of serial sections. This has proved of the greatest importance, especially in embryology.

Hittorf, Johann Wilhelm

German chemist
b. Mar. 27, 1824, Bonn
d. Nov. 28, 1914, Münster

Professor at Münster University, Hittorf contributed to the study of electrolysis, especially of salt solutions, and it is to him that the first suggestion of transport numbers is due. He studied electrical discharge in rarefied gases with the Hittorf tube, and, previous to Crookes, the effect of a magnetic field on cathode rays. He wrote on ion migration in electrolysis (1903-4).

Hjelm, Peter Jacob

Swedish chemist
b. 1746, Sunnerbo Harad
d. 1813, Stockholm

In 1781 Hjelm succeeded in isolating metallic molybdenum, which is much used now in the construction of wireless valves. After holding a situation at the Royal Mint, Stockholm, he became director of the chemical laboratory at the Bureau of Mines. He was a close friend of Scheele.

Hodgkin, Thomas

English physician
b. Aug. 17, 1798, Tottenham, Middlesex
d. Apr. 5, 1866, Jaffa, Palestine

After studying in London, Paris and Edinburgh, Hodgkin worked at Guy's Hospital. He is remembered as the first to describe the glandular disease named after him, the signs of which include enlargement of the spleen and lymphatic glands (*lymphadenoma*).

Hoff, Jacobus Henricus van't

Dutch chemist
b. Aug. 30, 1852, Rotterdam
d. Mar. 1, 1911, Steglitz, Berlin

Educated at the University of Leyden, van't Hoff became in 1876 assistant in the Veterinary College at Utrecht, and, in 1877, professor of chemistry at Amsterdam, Leipzig (1887) and Berlin (1895). At Amsterdam his work laid the foundations of modern physical chemistry. He propounded the fertile idea of an asymmetrical carbon atom independently of Le Bel (1874), and in 1884 he published *Studies of Dynamical Chemistry*, in which he dealt with reaction velocity and the application of thermodynamics to chemistry. In 1886 he published his fundamental work on the theory of dilute solutions. From Pfeffer's results he found that the osmotic pressure of a given concentration of solution is proportional to the absolute temperature. He was awarded the first Nobel prize for chemistry in 1901.

Hofmann, August Wilhelm von

German chemist
b. Apr. 8, 1818, Giessen
d. May 3, 1892, Berlin

After studying philosophy and law at

Göttingen, Hofmann turned to chemistry and became assistant to Liebig. From being the first professor in the College of Chemistry, London, he became professor of chemistry at Berlin in 1865. He was the founder of the German Chemical Society. A prodigious worker in organic chemistry, he was especially noted for his researches on aniline and its many derivatives. He discovered many organic compounds, e.g., formaldehyde (1867), and gave his name to a reaction for preparing primary amines from the amides of acids.

Hofmeister, Wilhelm Friedrich Benedict
German botanist

b. May 24, 1824, Leipzig

d. Jan. 12, 1877, Lindenau, nr. Leipzig

Though he was entirely self-trained, Hofmeister's book *On the Embryology of Flowering Plants* brought him to the fore, and he eventually earned a professorial chair at Heidelberg and then at Tübingen. His fundamental work on plant embryology was followed by a clear explanation of the alternating cycle of mosses and ferns, a piece of epoch-making research which fundamentally affected plant classification. He was regarded as the foremost German botanist of his time.

Hogben, Lancelot

British physiologist

b. Dec. 9, 1895, Southsea, Hants.

Educated at Cambridge, after holding many academic appointments at Edinburgh, McGill, Cape Town and London, etc., Hogben became professor of zoology at Birmingham in 1942. He showed that colour changes in a frog are caused by secretion from the pituitary gland at the base of the brain. His publications include various popular and scientific works.

Hohenheim, Theophrastus Bombastus von. See **Paracelsus**

Holmes, Arthur

English geologist

b. Jan. 14, 1890, Hebburn-on-Tyne

Educated at London, Holmes travelled extensively in Africa and Burma before becoming professor of geology at Durham

in 1924 and at Edinburgh in 1943. He was elected F.R.S. in 1942 and is noted for his work on the age of the earth, particularly in regard to the important method of estimating the age of rocks from their radioactive end-products. He has written a number of text-books on geology, including *The Age of the Earth*.

Holmes, Oliver Wendell

American physician and writer

b. Aug. 29, 1809, Cambridge, Mass.

d. Oct. 7, 1894, Boston

Educated at Harvard, Holmes eventually became professor of anatomy there. His public reputation was gained mainly as an essayist and writer, but in 1843 he was the first to notice that puerperal fever was contagious and suggested that the strict cleansing of the hands of the operator would largely prevent it. This was an early move towards asepsis. See L. W. Townsend, *O. W. Holmes*.

Hooke, Robert

English chemist and physicist

b. July 18, 1635, Isle of Wight

d. Mar. 3, 1703, London

Hooke studied at Oxford for the Church, but, owing to his weak health, took up science as less strenuous. After the fire of London, his occupation as a surveyor brought him wealth but his miserliness was such that he kept his money locked in a chest. In 1665 he became professor of geometry at Gresham College. In 1660 Hooke discovered the law named after him which states that the extension of a spring is proportional to the force applied, and he also claimed to have discovered the law of gravitation before Newton. One of the first to use a microscope to examine minute objects, he discovered vegetable cells in 1667 while studying a thin section of dead cork. He was assistant to Boyle for some time and conducted some interesting experiments on combustion, and came close to the discovery of oxygen. Both Huygens and he claimed to be the inventor of the balance spring in watches, commonly called the hair-spring, in 1658. He was a skilful experimenter, and contributed towards the theory of gases and also

HOOKER

invented a Gregorian telescope. He calculated the centre of gravity of earth and moon, and was aware of the rotation of Jupiter. In addition he made substantial contributions to the theory of elasticity.

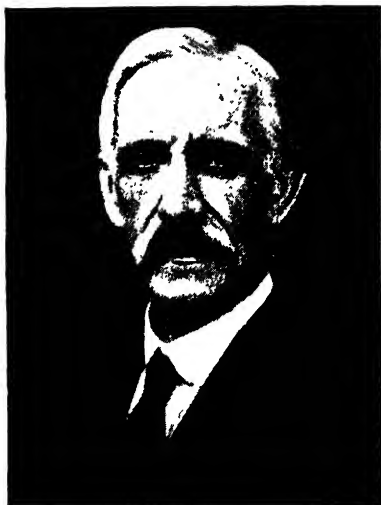
Hooker, Sir Joseph Dalton

English botanist

b. June 30, 1817, Halesworth, Suffolk

d. Dec. 10, 1911, Sunningdale, Berks.

Educated at Glasgow, Hooker was assistant on Sir James Ross's Antarctic expedition, as well as travelling widely in India, Palestine and the United States. He became director of Kew Gardens and president of the Royal Society. His friendship with Darwin led to his collaboration in Darwin's researches and to his being instrumental in persuading his friend to publish *On the Origin of Species*. He joined with George Bentham in producing the magistral *Genera Plantarum* (7 vols., 1862-83), giving their important system of classification; and was an authority on Antarctic flora. He became a member of the Order of Merit in 1907.



SIR FREDERICK GOWLAND HOPKINS,
pioneer in vitamin research and nutritional
chemistry.

Hope, Thomas Charles

Scottish chemist

b. 1766, Edinburgh

d. June 13, 1844, Edinburgh

Educated at Edinburgh, Hope became professor of chemistry at Glasgow and later at Edinburgh. He designed a piece of apparatus to determine the maximum density of water and his researches on this problem are classic. He and Crawford were the first to distinguish between baryta and strontia.

Hopkins, B. Smith

American chemist

b. Sept. 1, 1873, Owosso, Mich.

Educated at Columbia and the Johns Hopkins University, Hopkins became professor at the University of Illinois in 1912. He has done much research on the rare earths and claimed the discovery in 1926 of element No. 61, which he named illinium.

Hopkins, Sir Frederick Gowland

English biologist

b. June 30, 1861, Eastbourne, Sussex

d. May 16, 1947

Professor of biochemistry at Cambridge (1914-43), Hopkins was awarded the Copley medal in 1926 and shared with Eijkman the Nobel prize for medicine in 1929. He was president of the Royal Society, 1930-35, and of the British Association in 1933. He conducted classic researches at Cambridge in 1906 and 1907 which led to the discovery of essential amino-acids and of the accessory food factors now known as vitamins, the latter name being given by Casimir Funk of the Lister Institute in 1912. Hopkins also isolated tryptophane and glutathione and was engaged in work on lactic acid and muscular function. He became a member of the Order of Merit in 1935.

Horrocks, Jeremiah

English astronomer

b. 1619, Toxteth Park, Liverpool

d. Jan. 3, 1641, Toxteth Park

Educated at Cambridge, Horrocks became a curate at Hoole, and although short-lived he remains a brilliant astronomer. He is particularly remembered as the first

observer (1639) of a transit of Venus, which he had predicted, though he also did work on the tides and on the solar parallax.

Houssay, Bernardo
Argentine physiologist
b. 1887

Educated at Buenos Aires where he became professor of physiology, Houssay has done much research on internal secretions, such as adrenal, thyroid, and on diabetes as well as on snake and spider venoms. He was awarded the Nobel prize for medicine in 1947, jointly with the Cori.

Howe, Elias

American inventor

b. July 9, 1819, Spencer, Mass.

d. Oct. 3, 1867, Brooklyn, N.Y.

Trained as a machinist, Howe conceived the idea of a sewing-machine. His model took five years to complete and he had difficulty in gaining recognition for his work, but in 1854 was triumphant over his imitators.

Hrdlička, Aleš

American anthropologist

b. Mar. 29, 1869, Humpolec, Bohemia

d. Sept. 5, 1943

Hrdlička studied medicine in New York and worked in the State Pathological Institute on the anthropological aspects of insanity, and later was on the staff of the Natural History Museum of New York and the National Museum, Washington. He turned to the special study of the origins of man and brought forward new theories concerning the North American Indian, believing him to be of Asiatic origin.

Hubble, Edwin Powell

American astronomer

b. Nov. 20, 1889, Marshfield, Mo.

d. Sept. 28, 1953

Educated at Chicago and Oxford, Hubble became an astronomer at the Mt. Wilson Observatory in 1919. He discovered that, if the red shift is entirely due to recession, the apparent velocities of receding stellar systems are proportional to their distance, a statement known since as Hubble's Law.

Huber, François

Swiss naturalist

b. July 2, 1750, Geneva

d. Dec. 21, 1831, Pregny, nr. Geneva

A great expert on bees, though he was himself blind, Huber was able with his wife's help and that of an assistant to make observations and deductions of great value. His son Pierre did similar work on bees. The work on bees is embodied in *Nouvelles Observations sur les Abeilles* (1792) and includes the discovery of the fertilisation of the queen bee in flight, the functions of the antennae, the expulsion of the drones and other essential facts relating to the life history of the hive.

Huggins, Sir William

English astronomer

b. Feb. 7, 1824, Stoke Newington, London

d. May 12, 1910, London

The owner of a private observatory at Tulse Hill, South London, Huggins became an F.R.S. in 1865 and was president of the Royal Society from 1900 to 1905, being awarded the Copley medal. In 1868 he noted the shift of a line towards the red end of the spectrum of Sirius, denoting the recession of the star. He made similar observations on many other stars to determine the relative velocity of each star to the earth. He was the first to prove that certain nebulae are truly gaseous, and was a pioneer in the development of spectroscopic photography.

Hughes, David Edward

English inventor

b. May 16, 1831, London

d. Jan. 22, 1900, London

Living in America in his early life, Hughes was educated in Kentucky, and became a professor of music. Abandoning this, in 1855 he invented a printing telegraph that was widely adopted. He invented also the microphone in 1878 and the induction balance. He left a large fortune to London hospitals.

Humboldt, Friedrich Heinrich Alexander, Baron von

German naturalist and traveller

b. Sept. 14, 1769, Berlin

d. May 6, 1859, Berlin

HUNTER

After study at Frankfort-on-the-Oder, Berlin, and Göttingen, and in the mining school at Freiberg, Humboldt went on a five years' voyage of exploration to South America. This resulted in an enormous contribution to scientific knowledge, and later in life he made a similar excursion into Central Asia. He was the founder of physical geography and the first to draw isothermals on a map. One of the things which he brought back from South America was a sample of guano, the value of which as a manure had not been previously appreciated. Among the subjects of his study were the nature of tropical storms, terrestrial magnetism, plant zones and volcanoes. His main work *Kosmos* (1845-62) attempts a comprehensive physical picture of the universe, and is a fitting reflection of his vigorous intellect.

Hunter, John

Scottish physiologist

b. Feb. 13, 1728, Long Calderwood, Lanarkshire

d. Oct. 16, 1793, London

After a poor start in life as a cabinet-maker's assistant, Hunter became a surgeon

in London and accumulated a museum of anatomical specimens which was eventually bought for the nation. He was particularly interested in anatomical abnormalities. Unfortunately this famous collection was destroyed by enemy action during the last war. The greatest surgeon of his day, he was awarded the Copley medal, his original methods of operation being the means of saving many lives and limbs. He was, for example, the first to use a ligature for aneurism. He succeeded in grafting a cock's spur and a piece of chick's leg on to another fowl's comb, the first example of successful animal tissue-grafting. He investigated a large number of subjects from embryology to deer's antlers, and had as one of his pupils Edward Jenner.

Hutton, James

Scottish geologist

b. June 3, 1726, Edinburgh

d. Mar. 26, 1797, Edinburgh

After studying at Edinburgh and at Leyden, Hutton took the degree of M.D. at the latter university in 1749. From 1768 he devoted himself to scientific research. In 1785 he wrote *Theory of the Earth* in which he stated that present geological processes give the key to the formation of older rocks also. He corrected the misconceptions of Werner on the formation of the igneous rocks, and proved that granite is a product of hot mobile material. Hutton is regarded as the founder of the modern theory of the earth's crust. He was fortunate in finding in John Playfair (q.v.) an indefatigable advocate of his theory, and his ideas of igneous origin and atmospherical change, though received with unbelief, now form the basis of geological investigation. In 1794 appeared *Investigations of the Principles of Knowledge*, dealing with the metaphysics of subjective impressions; and in 1795 an enlarged version of his *Theory* (2 vols.).

Huxley, Thomas Henry

English biologist

b. May 4, 1825, Ealing, Middlesex

d. June 29, 1895, Eastbourne



THOMAS HENRY HUXLEY, the greatest exponent of the ideas of Charles Darwin.

The greatest biological teacher of the 19th century, Huxley was trained as a doctor at London University and became a surgeon in the Royal Navy. He was appointed professor of natural history at the School of Mines and occupied other academic posts of high distinction. He introduced the term *agnostic* to describe the current beliefs of many scientists of his time. He is remembered for his strong support of the theories of Darwin, which, as he was a recognised authority on anatomy, carried great weight in scientific circles. In 1870 he introduced the term *biogenesis* to describe the idea that living matter always arises from pre-existing living matter. See L. Huxley *Life and Letters of Thomas Henry Huxley*.

Huygens, Christiaan (or Huyghens)

Dutch mathematician and physicist

b. Apr. 14, 1629, The Hague

d. June 8, 1695, The Hague

After studying at Leyden and Breda, Huygens entered upon a life of scientific research. In 1663 he became an F.R.S. He investigated the properties of a com-

pound pendulum and was the first to apply it as a regulator of a clock (about 1657) and to the determination of the acceleration due to gravity. He was the first to prove that Saturn's ring entirely surrounds the planet and he determined the inclination of its plane to that of the ecliptic. Also the first in 1659 to make a drawing of Mars and the first to describe the great nebula in Orion, he was in 1671 the discoverer of Iapetus, a satellite of Saturn, and suggested that like our moon it shows always the same face to its primary. He designed a well-known eyepiece to reduce spherical aberration, and in 1678 he evolved his famous wave theory of light (pub. 1690) which did not gain much support since it failed to account for polarisation though satisfactory in its explanation of double refraction. This theory was in opposition to the corpuscular theory fathered on Newton, and both have had their adherents until their quasi-algamation in wave-mechanics. In 1661 Huygens introduced the plate and bell-jar type of air-pump. *Systema Saturnium* appeared in 1659, *Horologium Oscillatorium* in 1673.

I

Ingen-Hausz, Jan

Dutch physician

b. 1730, Breda

d. Sept. 7, 1799, Bowood, England

Educated at Louvain, Leyden, Paris and Edinburgh, Ingen-Hausz demonstrated in 1779 that green plants absorb carbon dioxide in the day and give it out at night, an epoch-making discovery, the value of which was not appreciated at the time. His work *Experiments on Vegetables* was published in 1779. He devised also a well-known method of comparing heat conductivities of rods.

Ingold, Christopher Kelk

English chemist

b. 1893

Educated at University College, Southampton, and the Imperial College of Science and Technology, where he lectured (1920-24), Ingold became professor of chemistry at Leeds (1924-30) and at University College, London (1930). His researches include studies of the structure of aromatic compounds, and important work on organic chemical reactions.

Ingrassia, Giovanni Filippo

Italian physician

b. 1510

d. 1580

A physician of Naples, Ingrassia was the first to differentiate between measles and scarlet fever.

Ipatieff, Vladimir Nikolaevich

American chemist

b. Nov. 9, 1867, Moscow; *d.* 1952

Of Russian birth, Ipatieff was educated at St. Petersburg and at Munich and Paris. He worked in St. Petersburg before going to America (1931) into technological science. In the catalytic chemistry of unsaturated hydrocarbons he has done important work of great significance to the oil industry.

Irvine, Sir James Colquhoun

Scottish chemist

b. May 9, 1877; *d.* June 12, 1952

Educated at Glasgow and Leipzig, Irvine became professor of chemistry at St. Andrews, and principal and vice-chancellor of the university (1921); he was elected an F.R.S. in 1918. He has made important researches on the chemistry of the sugars.

Ives, Frederic Eugene

American inventor

b. Feb. 17, 1856, Litchfield, Conn.

d. 1937

While engaged in the printing trade, Ives studied photography and especially the possibility of reproduction for illustration. He later took charge of the photographic laboratory at Cornell and it was here that he invented the half-tone process in 1878. In 1885 he discovered a more effective process which is still used. Other inventions of his were the short-tubed single-objective microscope, and also devices for producing coloured photographs.

J

Jacobi, Karl Gustav Jacob

German mathematician

b. Dec. 10, 1804, Potsdam

d. Feb. 18, 1851, Berlin

After studying at Berlin, Jacobi became professor of mathematics at Königsberg. He is noted for important work on elliptic functions and also on differential equations; and he introduced the theory of the last multiplier. He was one of the founders of the theory of determinants. His great work is *Fundamenta Nova Theoriae Functionum Ellipticarum* (1829).

Jacobsen, Carlyle

American psychologist

b. Jan. 17, 1902, Minneapolis, Minn.

Educated at Minnesota, Jacobsen became instructor in psychology there from 1924 to 1928, going later to Yale, Harvard, Cornell, Washington and finally Iowa. He has performed experiments (at Yale with Fulton) on apes to show that heart and circulation work as hard in everyday actions as in extreme muscular exertion, and that the brain is responsible for many physical disorders such as sweating, blood pressure, etc.

Jacquard, Joseph Marie

French inventor

b. July 7, 17^c2, Lyons

d. Aug. 7, 1834, Oullins, Rhône

A worker in a Lyons factory, Jacquard was the inventor of the famous loom for figured weaving, named after him. This he later improved by incorporating details from Vaucanson's loom and eventually was rewarded with a pension and a royalty per loom. He suffered from mob attack from weavers in his home town, who feared loss of employment because of his invention.

James, Charles

English-American chemist

b. 1880, Earls Barton, Northampton, Eng.

d. 1928, Boston, U.S.A.

Educated at University College, London, James went to America and became professor of chemistry at the University of New Hampshire. He discovered the rare earth, lutecia, but his results were not published before those of Urbain who therefore holds the credit for this discovery. He was an expert on the separation of the rare earths.

James, William

American psychologist

b. Jan. 11, 1842, New York

d. Aug. 26, 1910, Chocorua, N.H.

Brother of Henry James, the novelist, and educated at Harvard in medicine and on the continent under Helmholtz and Virchow, William James became instructor in physiology at Harvard (1872) and professor in 1881. He taught psychology as a laboratory science, a great innovation at the time. With Lange he produced a theory of emotion which carries their joint name. Later he turned to philosophy and became the leader of Pragmatism. He has exerted a profound influence on the progress of modern thought. Among his works are *Principles of Psychology* (1890) and *The Varieties of Religious Experience* (1902). See T. Flournoy, *The Philosophy of William James* (1911).

Jamin, Jules Célestin

French physicist

b. 1818

d. 1886

The director of the physical laboratory in the Sorbonne from its foundation in 1868 to his death, Jamin invented an interferometer to make interference fringes by a method originally due to Brewster.

Janet, Pierre Marie Félix

French psychologist

b. May 30, 1859, Paris

d. Feb. 24, 1947

Educated in Paris, Janet lectured on

JANSEN



EDWARD JENNER, the country doctor who revolutionised the treatment of smallpox and began immunology.

philosophy and was also director of the psychological laboratory at la Salpêtrière. He eventually became professor of psychology at the Collège de France. He did much work on hysteria, obsessions, neuroses and allied topics, and wrote a number of text-books on these subjects, including *The Major Symptoms of Hysteria* (1907) and *Les Méditations Psychologiques* (1920). His theory of hysteria (described by Freud as the first significant psychological theory) regarded the state as 'dissociation' or failure of synthesis due to a lowering of psychic energy, and was based on clinical observations by Charcot, under whom he studied.

Jansen, Zacharias
Dutch optician
c. 1600

The actual, though accidental, discoverer in 1609 of the telescope through placing two lenses in a tube, Jansen had however no appreciation of the value of his discovery. Some authorities credit Hans Lippershey with the invention.

Janssen, Pierre Jules César

French astronomer

b. Feb. 22, 1824, Paris

d. Dec. 23, 1907, Paris

Educated at Paris in physics and chemistry, Janssen became professor of physics and later the head of the Astrophysical Observatory at Meudon. He was lame from childhood. After the eclipse of 1868 he was encouraged to try to observe the bright line spectrum of the solar atmosphere when there was no eclipse. His success was an epoch-making discovery, shared by Lockyer who independently devised the same method of observing the prominences.

Japp, Francis Robert

Scottish chemist

b. Feb. 8, 1848, Dundee

d. Aug. 1, 1925

Of Dutch extraction, Japp was educated at St. Andrews and studied law at Edinburgh. Later he turned to chemistry and studied at Heidelberg and Bonn under Bunsen and Kekulé respectively. Elected F.R.S. in 1885, he became professor of chemistry at Aberdeen in 1890, and did original work on benzil, benzoïn and phenanthraquinone.

Jeans, Sir James Hopwood

English mathematical physicist

b. Sept. 11, 1877, London

d. Sept. 16, 1946

Educated at Cambridge, Jeans was president of the Royal Astronomical Society from 1925-27, and of the British Association in 1934. He became professor of astronomy at the Royal Institution and was the author of many books on astronomical problems. Beginning with work on the dynamical theory of gases, he did research on stellar dynamics and was one of the developers of the fission theory of the birth of binary and multiple star systems. He also put forward a theory about the development of spiral nebulae and proposed the tidal theory of the origin of planets. This latter suggests the withdrawal of solar material to form planets by the near passage of a neighbouring star. He pointed out that the energy of motion of all stars is approximately equal, that is that small stars move rapidly and

large ones move slowly. He showed that the radiation from uranium corresponds to a temperature of 5,800 million degrees centigrade.

Jeffreys, Harold

English geophysicist

b. Apr. 22, 1891, Birtley, Durham
Educated at Newcastle-on-Tyne and Cambridge, Jeffreys became reader in geophysics at Cambridge in 1931. An authority on the early history of the earth and the origin of the solar system, he was one of the first to investigate the effect of radioactivity on the cooling of the earth and on mountain formation. He developed Sir James Jeans' theory of the tidal evolution of the solar system and estimated its age as a few thousand million years, from a consideration of Mercury's orbit. He also calculated that the moon would have taken four thousand million years to recede to its present position. He suggested independently of Craig that Mercury might have been a satellite of Venus captured by the sun.

Jenner, Edward

English physician

b. May 17, 1749, Berkeley, Glos.

d. Jan. 24, 1823, Berkeley, Glos.

After studying under Ludlow and Hunter, Jenner began in 1776 to study smallpox. In his country practice he noticed that milkmaids with cowpox sores on their hands were immune from smallpox. As a result, in 1798, he developed the famous process of vaccine inoculation by injecting cowpox vaccine, and after great opposition from his fellow-members of the medical profession the discovery was universally adopted. He also published a well-known paper on the cuckoo.

Jenner, Sir William

English physician

b. Jan. 30, 1815, Chatham

d. Dec. 11, 1898, Bishop's Waltham, Hants.
Educated at London University, Jenner became professor of pathological anatomy at University College. He was elected F.R.S. in 1864 and was one of the Queen's physicians. His fame rests upon his

original research on fevers which led to his distinguishing typhoid from typhus.

Johannsen, Wilhelm Ludwig

Danish botanist

b. 1857

d. 1927

Johannsen was a geneticist of repute, whose pure-line theory was the result of a long series of experiments with Princess beans. A pure-line is a self-fertilised individual, and all in its group possess the same hereditary constitution with all the factors in duplicate.

Johnston, Herrick Lee

American chemist

b. Mar. 29, 1898, North Jackson, O.

Educated at Muskingum, Wooster and California, Johnston worked at Ohio State University, at California, and finally returned to Ohio as professor of chemistry. He was director of the Manhattan Project Research from 1942 to 1946. He was associated with Giauque in his famous work on low temperatures in which less than a degree from absolute zero was reached.

Joliot, Jean Frédéric (Joliot-Curie)

French physicist

b. Mar. 19, 1900, Paris

Trained first as an engineer, Joliot later studied chemistry and became lecturer at the Faculty of Sciences and professor at the Radium Institute, Paris. In 1933 with his wife, Irène Joliot-Curie (see below), he produced an artificial radioactive substance by bombarding boron with fast alpha particles, and in 1935 they shared the Nobel prize for chemistry. In 1939 with Halban and Kowarski he proved experimentally that neutron emission takes place in nuclear fission. He was appointed director of the National Centre for Scientific Research, and High Commissioner for Atomic Energy in France (1946). He was removed from both posts by the Government in 1950 because of his Communist sympathies.

Joliot-Curie, Irène

French physicist

b. Sept. 12, 1897, Paris

Daughter of Madame Pierre Curie, Irène

JOLY

Curie was educated at the Sorbonne, and became a research worker at the Curie Laboratory. She shared the Nobel prize for chemistry in 1935 with her husband, Frédéric Joliot. In 1933 they produced an artificial radioactive substance by bombarding boron with fast alpha particles.

Joly, John

Irish geologist

b. 1857, Hollywood, King's County.

d. Dec. 8, 1933

Educated at Dublin, Joly became professor of geology and mineralogy there in 1897. In 1888 he invented a photometer, based on paraffin wax slabs separated by a tinfoil sheet, to measure illumination. The slabs are viewed edge-on and the sources moved until both slabs are equally bright. He also designed a well-known steam calorimeter. In 1899 he measured the age of the oceans by estimating the rate of deposit of sodium. He proved that pleochroic haloes are the result of alpha-particles shot out from minute crystals of zircon and allanite (both radioactive), and so arrived at a method of estimating the age of rocks. Among his contributions to that field is pioneer work on the cooling of the earth with respect to the theory of isostasy and the radioactive heating of the crust. He was distinguished also for his work on the 'Dublin method' of radium extraction (1914), and for his pioneer work on the radium treatment of cancer. He was elected F.R.S. in 1892.

Jordan, Camille (Marie Ennemond

Camille)

French mathematician

b. Jan. 5, 1838, Lyons

d. Jan. 20, 1922, Milan

Educated at Paris, Jordan became professor of mathematics at the École Polytechnique. He was the editor of the *Journal de Mathématiques*. His early work lay principally in the field of geometry and he extended Galois' work on group substitutions to algebraic equations. His later work was concerned with the theory of functions, and he applied the theory of the function of bounded variation to the particular curve which carries his name.

Joule, James Prescott

English physicist

b. Dec. 24, 1818, Salford, Lancs.

d. Oct. 11, 1889, Sale, Cheshire

The fact that Joule worked in a private laboratory and held no academic posts to some extent explains why his theories gained very little notice at the time. In 1860, however, he was awarded the Copley medal and he was an F.R.S. He discovered the law of heating in an electric conductor, that is, that the heat is proportional to the resistance times the square of the current. He conducted (1843-78) classic researches into the mechanical equivalent of heat, his result being 4.18×10^7 ergs per therm. This identity of heat and work provided the basis for the theory of the conservation of energy. Presenting a paper, in 1843, to the Royal Society, *On the Calorific Effects of Magnetic Electricity and the Mechanical Value of Heat*, he roused no great interest, but when he returned to the subject in 1847 Lord Kelvin (then William Thomson) was strong in his praise. Joule's calorimeter is preserved in the South Kensington Museum, and the unit of energy is named after him. He also stated the law that the energy of a gas is a function of its temperature, and that the molecular heat of a solid compound is equal to the sum of the atomic heats of its components. The Joule-Thomson (Joule-Kelvin) effect is the fall in temperature when a gas expands without doing external work; it is the basis of the Linde method of liquefying gases. The Joule effect is the heating caused by electric current flowing through a resistance; and Joule's equivalent is the same as the mechanical equivalent of heat (see above). He described magnetostriction for the first time, and made the first calculation of the velocity of a gas molecule, his result being $v=6,225$ ft./sec. (the accepted modern value is $v=6,034$ ft./sec.). Joule's complete papers were published by the Physical Society (1885-87).

Jung, Carl Gustav

Swiss psychologist

b. July 26, 1875, Basle

Educated at Basle and Paris, Jung became professor of psychology at Zürich (1933-41)

and at Basle in 1943. He evolved a theory of complexes, and was associated with Freud in the development of psycho-analysis, later dissociating himself because they disagreed on the degree of importance which should be attached to sex-impulse in the determination of human motives. Jung opposed Freud's sex-impulse motive and Adler's will-to-power motive by regarding the libido as a general urge to live. He founded a school of psycho-therapy at Zürich. His conception of neurosis is that it is a result of present maladjustment and conflict rather than of memories and experiences of childhood and infancy. He made a significant division of mental types into, introvert and extrovert and stressed

the importance of balance in this respect. He is the author of many books on psychology.

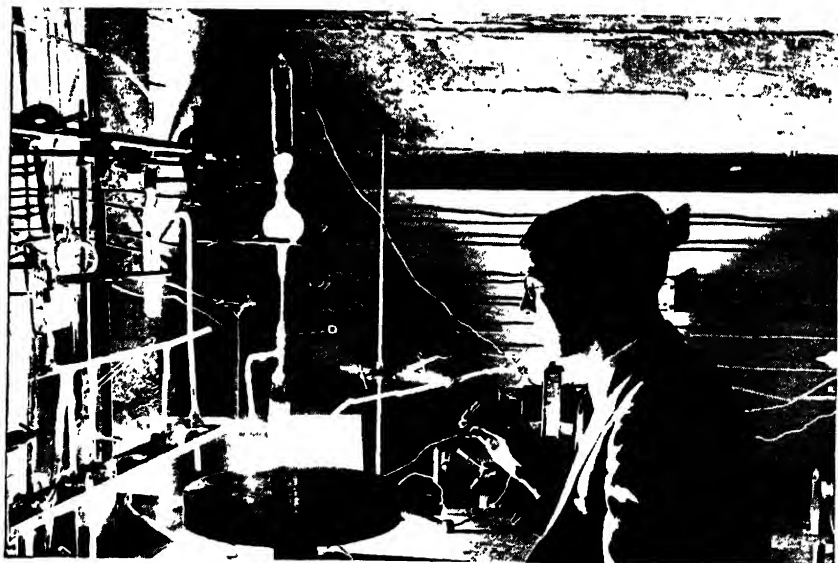
Jussieu, Antoine Laurent de
French botanist •

b. Apr. 12, 1748, Lyons

d. Sept. 17, 1836, Paris

One of five famous botanists in this family, Jussieu studied at Paris and published in 1789 his *Genera Plantarum*, which formed the basis of modern natural botanical classification. He was professor of botany at the Muséum d'Histoire Naturelle, and during the revolution was in charge of the Paris hospitals.

K



JOSEPH KAPLAN reproduces the flicker of aurora borealis for the first time in the laboratory, May, 1931.

Kamerlingh Onnes. See Onnes, K.

Kane, Sir Robert John

Irish chemist

b. 1809, Dublin

d. 1890, Dublin

Educated for the medical profession, Kane became in 1834 professor of natural philosophy at Dublin. He was one of the earliest promoters of the radical theory, and in 1833 he proposed that alcohol, ether and muriatic ether could be regarded as compounds of the radical C_2H_5 . In his own words, his idea was received with amusement and ridicule in chemical circles at Dublin, but nevertheless he was completely justified by subsequent research.

Kapitza, Peter (Petr Leonidovich Kapitza)

Russian physicist

b. June 26 (o.s.), 1894, Kronstadt

After studying at Petrograd, and at Cambridge under Rutherford, Kapitza became assistant director of magnetic research, Cavendish laboratory (1924-32) and Messel research professor at the Royal Society Mond laboratory (1930-35). He was elected F.R.S. in 1929, and was awarded the Faraday medal in 1942, the Stalin prize for physics (1941 and 1943), and the Order of Lenin (1943 and 1944). He is known for his work on magnetism and low temperature, especially the production of intense magnetic fields up to 300,000

gauss, and the design of hydrogen and helium liquefaction plants. In 1934, while on a visit to the U.S.S.R., he was detained in that country, subsequently becoming the director of the Institute for Physical Problems, Moscow.

Kaplan, Joseph
American physicist

b. Sept. 8, 1902, Tapolcza, Hungary

In America from his eighth year, Kaplan was educated at the Johns Hopkins University and became a research fellow at Princeton in 1927. He was appointed professor of physics at the University of California. Famous for his work on spectroscopy, he produced the aurora spectrum in the laboratory and discovered new nitrogen spectra. He also discovered atomic nitrogen in the earth's upper atmosphere.

Kapteyn, Jacobus Cornelius
Dutch astronomer

b. 1851

d. 1922

Professor of astronomy at Groningen from 1878 to 1921, Kapteyn was one of the greatest astronomers of his time. He showed that all stars whose proper motion can be detected belong to one of two streams moving in different directions, one stream moving about three times as fast as the other. The sun is in the slower stream. He plotted the stars in Gill's plates of the southern hemisphere, and with Rhijn he evolved a theory of the universe.

Karrer, Paul
Swiss chemist

b. Feb. 4, 1889, Moscow

Educated at Zürich, Karrer became professor of organic chemistry there (1919) after a period of work with Ehrlich at Frankfurt. He was awarded the Nobel prize for chemistry in 1937 (with Haworth) for his pioneer work on vitamins (A and B₂) and on the flavins and carotenoids.

Kater, Henry
English physicist

b. Apr. 16, 1777, Bristol

d. Apr. 26, 1835, London

Of German descent, Kater trained for the law but entered the army. While an army surveyor he devised an improved form of pendulum, named after him. He was elected F.R.S. in 1815 and did much valuable work on improvements in measuring instruments, for which he gained the Copley medal in 1817. His accurate determination of the length of the seconds pendulum led to increased accuracy in the British system of weights and measures.

Keeler, James Edward
American astronomer

b. Sept. 10, 1857, La Salle, Ill.

d. Aug. 12, 1900

Educated at the Johns Hopkins University, Heidelberg and Berlin, Keeler finally became director of the Lick Observatory in 1898. He used the Doppler displacement of spectral lines to prove that Saturn's rings are composed of small fragments, as Maxwell had suggested. He measured the wavelength of the green line of nebular spectra, and discovered photographically some 120,000 nebulae, concluding that spiral nebulae were the predominant type. He wrote *Spectroscopic Observations of Nebulae* (1894).

Keesom, Wilhelmus Hendrikus
Dutch physicist

b. 1876

Educated at Amsterdam, Keesom became professor of physics at Leyden in 1923. Working in the laboratory of Kamerlingh Onnes at Leyden, in 1926 he succeeded in solidifying helium at 2.2°K and 50 atmospheres pressure; it had been the last gas to resist solidification.

Keilin, David
English biologist

Educated at Cambridge, Keilin became professor of biology there in 1931 having been elected F.R.S. in 1926. He showed the existence of the *cytochrome*, a pigment occurring inside some cells (bacteria, yeast) and having some possible connection with respiration. He has conducted a distinguished series of researches on biochemistry and higher Diptera.

KEITH

Keith, Sir Arthur

Scottish anthropologist

b. Feb. 5, 1866, Aberdeen

Educated at Aberdeen, London and Leipzig, Keith became a professor at the Royal College of Surgeons (1908), and Fullerton professor of physiology, Royal Institution (1917-23). He was elected F.R.S. in 1913, was president of the British Association in 1927, and rector of Aberdeen University (1930-33). His many discoveries in embryology and anatomy in connection with the history of man's early development and fossil man enabled him in 1927 to suggest significant modifications to Darwin's theory of the ancestry of man. His work marks him as one of the outstanding modern anthropologists. His many books include *Human Embryology and Morphology* (1901) and *A New Theory of Evolution* (1948).

Kekulé von Stradonitz, Friedrich August
German chemist

b. Sept. 7, 1829, Darmstadt, Hesse

d. July 13, 1896, Bonn

After studying architecture at the University of Giessen, Kekulé turned to chemistry and studied under Dumas. He became professor of chemistry at Ghent in 1858 and at Bonn in 1867. Famous for his theory of the ring structure of organic molecules and for his work on valency, he synthesised acetylene in 1864. He discovered the quadrivalence of carbon. His conception of the ring structure of benzene (1865) is cardinal to modern organic chemistry, and was the result of his dreaming of a serpent catching its own tail.

Kelvin, William Thomson, Lord

Scottish mathematician and physicist

b. June 26, 1824, Belfast

d. Dec. 17, 1907, Largs, Ayr

Educated at Glasgow and Cambridge, Kelvin became in 1846 professor of natural philosophy at Glasgow. He was president of the British Association in 1871 and of the Royal Society from 1890 to 1895. He was regarded as the leading scientist of his age, and was one of the original members of the Order of Merit (1902). He invented the mirror galvanometer, used in the



WILLIAM THOMSON, LORD KELVIN,
the greatest name in Victorian science.

reception of cable messages, and the Kelvin Standard Balance, a dynamometer by which mechanical moments are balanced by electrical moments. The designer of a gyrostat, he suggested a gyrostatic compass in 1883, and he also invented the quadrant electrometer, an instrument used for measuring extremely small differences of electrical potential, and investigated electric oscillation by mathematical analysis. He discovered the law named after him which connects the cost of a cable with its electrical losses, and was created Baron after the successful laying of the Atlantic cable, for the theoretical work on which he was responsible. One of his improvements of the mariner's compass was the replacement of a large single needle by eight small ones. A friend of Joule's, his development of the latter's work firmly established the theory and practice of thermodynamics. He was the first to define the absolute scale of temperature, designed a vapour pressure thermometer to read from 100° to 500° C., and made major contributions to the study of heat engines. He made an estimation of the density of the ether as 5×10^{-18} gms.

per c.c., and calculated the energy radiated from the sun's surface as 7,000 horse-power per sq. ft. The first to estimate the age of the earth from solidification as between forty and four hundred million years (probably 100), he also, with Helmholtz, estimated the age of the sun on the assumption of simple contraction as about fifty million years, but both these calculations were based on invalid premises. He modified Rayleigh's wave theory of light, which had corrected Fresnel's theory of reflection and refraction. His 300 and more original papers left hardly an aspect of science untouched, and not the least important facet of his contribution was the constant stream of suggestions which inspired research and discovery by others. He was an extreme mechanist, and stated that he could understand nothing of which he could not make a model.

Kendall, Edward Calvin
American chemist

b. Mar. 8, 1886, S. Norwalk, Conn.
Educated at Columbia, Kendall became professor of physiological chemistry at Rochester, Minnesota. He succeeded in 1915 in isolating thyroxine, the active principle of the thyroid gland. With Hench and Reichstein he shared the 1950 Nobel medicine prize for work on adrenal hormones (cortisone).

Kennelly, Arthur Edwin
American engineer
b. 1861, Bombay
d. 1939

An assistant of Edison and later professor of Harvard (1902), Kennelly is known for his work on magnetism in engineering and on alternating currents. He discovered the ionised layer in the atmosphere, generally known as the Heaviside layer, in the same year as Heaviside (1902).

Kepler, Johannes
German mathematician and astronomer
b. Dec. 27, 1571, Weil, Württemberg
d. Nov. 15, 1630, Ratisbon
In 1593, after studying at Tübingen, Kepler became professor of mathematics at Graz. Owing to the religious persecution of the Protestants he left for Prague



JOHANNES KEPLER whose work underlay
Newton's theory of gravitation

to work with Tycho Brahe, and inherited Brahe's papers and observations. As a result, he formulated his three laws of motion which have proved so important in astronomy, and enabled Newton to reach the law of gravitation. Kepler's laws are:—1. Each planet describes an ellipse with the sun at a focus. 2. The radius vector sweeps out equal areas in equal times. 3. For two planets the squares of the periods are proportional to the cubes of their mean distances from the sun. He suggested that the tides were caused by the attraction of the moon. He also worked on optics and mathematics, was profoundly convinced of the mathematical nature of the universe, and laid great stress on experimental verification. Of his many works the most famous is *Astronomia nova aëtiologhētōs, seu Physica Coelestis tradita Martis commentarius de motibus stellae* (1609) and in 1627 he produced the great *Rudolphine Tables*. His private life was troubled as he first married a wealthy widow who went mad, and was subsequently unlucky in his second choice. Money troubles at one time forced him to fortune-telling (by astrology), but on his death he was found to have hoarded a

KERR

considerable amount of money. See K. Hildebrandt, *Kopernicus und Kepler* (1944).

Kerr, John

Scottish physicist

b. Dec. 17, 1824, Ardrossan

d. Aug. 18th, 1907, Glasgow

Educated at Glasgow in theology, Kerr became lecturer in mathematics at a training college and was elected F.R.S. In 1876 he discovered a magneto-optic effect named after him, concerning the rotation of the plane of polarisation of light travelling through a magnetic field during reflection from the polished pole of the magnet.

Keulen, L. van. See **Ceulen, L. van**

Kidd, John

English chemist and physician

b. Sept. 10, 1775, London

d. Sept. 17, 1851, Oxford

Educated at Oxford, Kidd studied medicine at Guy's Hospital before becoming professor of chemistry at Oxford in 1803 and later Regius professor of physic. He was an F.R.S., and with Garden in 1819 he discovered naphthalene in coal tar.

Kipping, Frederic Stanley

English chemist

b. 1863, Manchester

d. April 30, 1949

Educated at Manchester, Munich and London, Kipping became professor of chemistry at Nottingham. He was elected F.R.S. in 1897. He investigated silicon compounds and his discoveries led to their development and use instead of parallel carbon compounds in the production of new plastics capable of resisting higher temperatures. He collaborated with Professor Perkin in the production of textbooks on inorganic and organic chemistry.

Kircher, Athanasius

German mathematician

b. May 2, 1601, Geisa, Thuringia

d. Nov. 28, 1680, Rome

Educated in theology, Kircher taught philosophy at Würzburg before becoming professor of mathematics in Rome. The

author of many scientific books, especially on sound, he invented the Aeolian harp, gave the first account of the bell-in-vacuo experiment, though drawing the wrong conclusions from it, and invented the magic lantern. He later turned to archaeology.

Kirchhoff, Gustav Robert

German physicist

b. Mar. 12, 1824, Königsberg

d. Oct. 17, 1887, Berlin

Professor of physics at Heidelberg and afterwards at Berlin, Kirchhoff is remembered for his developing with Bunsen of the spectroscope and their subsequent work on spectrum analysis. He identified many iron lines in the sun's spectrum and showed by experiment that the dark lines are caused by absorption in the cold vapour of the substance concerned. He discovered the law named after him stating that a substance which emits waves of definite periods when heated, selectively absorbs the same waves when cool, and in electrical engineering enunciated two fundamental laws connected with the electric circuit. In 1860 with Bunsen he discovered the elements caesium and rubidium by spectrum analysis.

Kirwan, Richard

Irish chemist

b. 1733, Cloughballymore, Galway

d. June 1, 1812, Dublin

Educated in France, Kirwan was the first to suggest that hydrogen was identical with phlogiston. In 1783 he investigated the combining proportions of acids and bases and was one of the first to investigate strontia. In 1782 he was awarded the Copley medal, having been elected F.R.S. in 1780.

Kitaibel, Paul

Hungarian chemist

b. 1757, Nagy-Marton

d. 1817, Budapest

Educated at Buda in chemistry and botany, Kitaibel discovered tellurium in 1789 independently of Müller. Like Muller he communicated his results to Klaproth, which led to an unfortunate

controversy later as to who was the true discoverer of this metal. He was professor of botany and chemistry at Pest from 1794.

Kitasato, Shibasaburo

Japanese bacteriologist

b. Dec. 20, 1856, Kumamoto

d. June 13, 1931, Nakanodo

After working in Germany under Koch, Kitasato founded the Institute for Infectious Diseases in Japan, being himself director in 1891. He discovered the bacillus of bubonic plague in 1894, independently of Yersin, and with Behring discovered the tetanus antitoxin; he also isolated the symptomatic anthrax, dysentery and tetanus bacilli, and evolved a diphtheria antitoxin.

Kjeldahl, J.

Danish chemist

b. 1849

d. 1900

Famous for his analytical methods of determination, Kjeldahl is especially remembered for the method of nitrogen determination named after him.

Klaproth, Martin Heinrich

German chemist

b. Dec. 1, 1743, Wernigerode, Prussia

d. Jan. 1, 1817, Berlin

After a penurious childhood, Klaproth was apprenticed to an apothecary and eventually rose to become the first professor of chemistry at the University of Berlin. By his improved methods of mineral analysis he discovered strontium compounds, titanium compounds, chromium in 1798, zirconia, and uranium (in pitchblende) in 1789, and cerium oxide. Some of these were discovered independently by contemporary chemists. He named tellurium which had been discovered by Müller. See Kitaibel.

Klaus, Karl Karlovich (or Claus)

Russian chemist

b. 1796, Dorpat

d. 1864, Dorpat

Educated at Dorpat, Klaus became a pharmacist and later assistant chemist at Dorpat University, eventually becoming professor of pharmacy and chemistry

there. Noted for his researches on the platinum residual metals, he is credited with the discovery of ruthenium, forecast by Osann but not isolated by him (1845).

Knight, Thomas Andrew

English agriculturalist

b. Aug. 12, 1759, Ludlow, Hereford

d. May 11, 1838, London

Interested as he was in the improvement of agriculture, Knight is remembered for the invention of a machine named after him, which established the principle of geotropism. In this machine germinating seeds could be subjected to centrifugal force in either a horizontal or vertical position. When gravity was thus replaced by centrifugal force it was found that the roots grew outwards and the stems inwards towards the centre. Other tropisms have since been demonstrated, e.g., phototropism and heliotropism.

Koch, Robert

German bacteriologist

b. Dec. 11, 1843, Klausthal, Hanover

d. May 28, 1910, Baden-Baden

After studying medicine at Göttingen, Koch practised at Wollstein (1872-80) and, following a visit to Egypt to study cholera, became professor at Berlin (1885) and director of the Institute for Infectious Diseases (1891). In 1876 he isolated the anthrax bacillus, and perfected a method of inoculation against it in 1883; in 1882 he discovered the tuberculosis bacillus and in the following year the comma bacillus of Asiatic cholera; in 1890 he evolved tuberculin culture, and in 1896 a vaccination for rinderpest. He investigated also bubonic plague, malaria and trypanosome diseases. He gained the Nobel prize for medicine in 1905. Much of his success was due to his introduction of new technique in the use of the microscope; he was, for example, the first to use aniline dyes to stain his organisms. See *Life* by Heymann (Leip. 1932).

Kocher, Emil Theodor

Swiss surgeon

b. Aug. 25, 1841, Berne

d. July 27, 1917, Berne

KOENIG

Educated at Berne, Kocher became professor there (1872-1917), and is remembered for his work on the thyroid gland in the fields of physiology, pathology and surgery. He also did much work on dislocations. In 1909 he gained the Nobel prize for medicine.

Koenig, Karl Rudolph

German physicist

b. Nov. 26, 1832

d. Oct. 2, 1901

Educated at Königsberg, Koenig became an authority on sound. Settled in Paris, he invented a famous clock fork for the determination of absolute pitch, and also invented the manometric flame for the study of air vibrations.

Koffka, Kurt

German-American psychologist

b. 1886, Berlin

d. 1941

Becoming professor of psychology at Smith College in 1932, Koffka was, with Wertheimer and Kohler, one of the founders of the Gestalt School of Psychology. This brings forward the idea that the mind perceives situations as a whole and not as a collection of parts, that is that mental processes function and must be analysed in terms of integrated systems of phenomena (Gestalten) whose totality is not deducible from the sum of the parts.

Köhler, Wolfgang

German-American psychologist

b. Jan. 21, 1887, Reval, Esthonia

Educated at Wolfenbüttel, Tübingen, Bonn and Berlin, Köhler went to the U.S.A. in 1935 after working at Frankfurt-on-Main, he had previously been director of the anthropoid station at Tenerife, and professor of psychology at Göttingen and Berlin. He became professor of psychology at Swarthmore College, Pa. He has done important work on the mentality of apes, finding, for example, that their mentality varies from individual to individual in the same way as human intelligence varies, and has written on this (1925) and on *Gestalt Psychology* (1929).

Kohlrausch, Friedrich Wilhelm Georg

German physicist

b. Oct. 14, 1840, Rinteln-on-Weser

d. Jan. 17, 1910, Marburg

After studying at Göttingen and Erlangen, Kohlrausch held professorships at several German universities before being professor of physics at Berlin (1895). He is noted for his researches on measuring methods and on electrolytic conductivity, in which connection he stated the equation bearing his name and referring to the dilution of strong electrolytes. He was the author of a widely-known handbook on practical physical method.

Kolbe, Adolf Wilhelm Hermann

German chemist

b. Sept. 27, 1818, Göttingen

d. Nov. 25, 1884, Leipzig

After studying under Wohler, Bunsen and Playfair, Kolbe finally became professor of chemistry in Leipzig in 1884. He made some enemies by his caustic criticisms of contemporary work. He synthesised acetic acid in 1848 and salicylic acid, and was the first to use the term *synthesis*. This conception did a great deal to destroy the distinction between organic and inorganic chemistry. He advanced a theory of radicals and suggested the existence of secondary and tertiary alcohols.

Kölliker, Rudolf Albert von

Swiss biologist

b. July 6, 1817, Zurich

d. Nov. 2, 1905, Würzburg

A pupil of Oken, Müller and Henle, Kölliker was a professor at Zürich and then at Würzburg. A contemporary of Darwin, he made some pertinent criticisms of evolutionary theory though he accepted it within limits. He noted, with Nageli and Huxley, that evolution could proceed by jumps as well as by gradual steps. The first book on histology was written by him and he produced a fine text-book on embryology. He was the first to show (1889) that nerve-fibres are enormously elongated processes given off from nerve-cells.

Koplik, Henry
 American physician
b. 1858
d. 1927

Concerning himself specifically with the diseases of childhood, Koplik is remembered by his discovery of certain spots, named after him, which appear on the mucous membrane of the lips and cheeks, and are diagnostic of measles.

Kopp, Hermann Franz Moritz
 German chemist
b. Oct. 30, 1817, Hanau, Prussia
d. Feb. 28, 1892, Heidelberg

After study at Marburg and Heidelberg, Kopp became professor of chemistry at Giessen and Heidelberg, being one of the founders of physical chemistry and a historian of the subject. He worked on atomic and molecular volumes, crystallography, boiling points, specific heats and dissociation.

Köppen, Wladimir P.
 Russian meteorologist
b. Sept. 27, 1846
d. June 22, 1940, Graz

An authority on climatology, Koppen worked at the German Naval Observatory, Hamburg, for over forty years (1875-1918). The association of sunspots and rainfall was studied by him, but, although there is some evidence of connection between the two, our knowledge of the relationship is still uncertain.

Kossel, Albrecht
 German physiological chemist
b. Sept. 16, 1853, Rostock, Switz.
d. July 5, 1927, Heidelberg

Educated at Strasbourg and Rostock, Kossel held several posts at Strasbourg, Berlin and Marburg before finally going to Heidelberg as professor of physiology from 1901-23. The Nobel prize winner for medicine in 1910, he is famous for his investigation of the chemistry of cells and of proteins.

Kossel, Walther
 German physicist
b. 1888

Son of Albrecht (above), after studying at Heidelberg, Kossel went to Kiel in 1921 as professor of physics, and in 1932 to Danzig. He has done much research work on atomic physics, especially on Röntgen spectra, and advocated a physical theory of chemical valency.

Kovarik, Alois Francis
 American physicist

b. Mar. 8, 1880, Spillville, Iowa
 Educated at Minnesota, Kovarik became professor of physics at Yale in 1925 after having held other academic appointments. He has done research on radioactivity, nuclear physics and the age of the earth, calculating the ages of rocks from estimations of the percentage of their radioactive end-product, lead.

Kraepelin, Emil
 German psychiatrist
b. Feb. 15, 1856, Neustrelitz
d. Oct. 7, 1926, Munich

Professor of psychiatry at Munich, Kraepelin was one of the earliest workers on the psychological study of mental diseases, though his method of classification of these into two groups is not now considered sound. His divisions were manic-depressive and dementia-praecox. His work on the fatigue of the brain and on the mental effects of alcohol was important.

Kraus, Charles August
 American chemist

b. Aug. 15, 1875, Knightsville, Indiana
 Educated at Kansas, the Johns Hopkins University and the Massachusetts Institute of Technology, Kraus held several high academic teaching posts before becoming professor of chemistry and director of research at Brown University in 1924. He has done notable work on the elements germanium and gallium, on liquid ammonia solutions, and on problems of vacuum sealing and electrical conduction.

Krogh, Schack August Steenberg
 Danish physiologist
b. Nov. 15, 1874, Grenaa
d. Sept. 13, 1949, Copenhagen

KUHN

Educated at Lund, Göttingen and Budapest, Krogh became professor of zoophysiology at Copenhagen. He is noted for his work on capillaries and osmosis and was awarded the Nobel prize for medicine in 1920 for his discovery of the regulation of the motor mechanism of capillaries. His chief work is *The Anatomy and Physiology of Capillaries* (1923).

Kuhn, Richard

Austrian chemist

b. Dec. 3, 1900, Vienna

Professor at the Kaiser Wilhelm Institute, Heidelberg (1929), after being at Munich and Zürich, Kuhn has done notable work on the structures and synthesis of vitamins and carotenoids. He was offered the Nobel prize for chemistry in 1938 but was obliged to decline on account of the Nazi attitude towards foreign awards. He studied also the chemistry of sex cells of algae.

Kühne, Wilhelm

German physiologist

b. Mar. 28, 1837, Hamburg

d. June 10, 1900, Heidelberg

After studying at Lüneburg, Göttingen,

Paris under Bernard, and Vienna under Virchow, Kühne entered the pathological laboratory at Berlin; he was professor at Heidelberg from 1871. He showed in 1864 that living protoplasm is a liquid by subjecting it to electric shock under which it tended to assume a spherical form. He introduced the term *enzyme* (Gk., 'in yeast') to describe organic substances which activate chemical changes, and studied the chemistry of digestive processes, and the physiology of muscles and nerves.

Kundt, August Adolph Eduard Eberhard

German physicist

b. Nov. 18, 1839, Schwerin, Mecklenburg

d. May 21, 1894, Israeldorf, nr. Lübeck

Educated at Leipzig and Berlin, Kundt became professor of experimental physics at Berlin in 1888. The inventor of Kundt's tube for the determination of the velocity of sound in gases and solids, he also carried out experiments on anomalous dispersion. He pointed out the connection between the refractive index of a metal and its specific electrical resistance.

L

Lacaille, Nicolas Louis de

French astronomer

b. Mar. 15, 1713, Rumigny, Ardennes

d. Mar. 21, 1762, Paris

After working with Cassini in his French survey, Lacaille became professor of mathematics at Mazarin College. He conducted an expedition to the Cape of Good Hope to determine lunar and solar parallax, and he also made observations there of 10,000 southern stars, as well as measuring an arc of the meridian.

La Condamine, Charles Marie de

French mathematician

b. Jan. 28, 1701, Paris

d. Feb. 4, 1774, Paris

Trained for the army, La Condamine went with Godin and Bouguer to Peru (1735) to measure an arc of the meridian. He left the others in order to explore the Amazon, the first scientific exploration, and he brought back curari and information of india-rubber. He was elected F.R.S. in 1748, and was an early advocate of inoculation.

Laënnec, René Théophile Hyacinthe

French physician

b. Feb. 17, 1781, Quimper, Brittany

d. Aug. 13, 1826, Kerlouanec, Brittany

Educated at Paris, Laënnec studied so unremittingly that he developed tuberculosis from which he subsequently died. He became a hospital physician and is famous for his invention of the stethoscope, made in 1816 as a result of seeing children tapping and listening at the end of a log of wood. In 1822 he became professor of medicine at the Collège de France but the strain of his work proved too much for him and he lived only another four years.

Lagrange, Joseph Louis

French mathematician

b. Jan. 25, 1736, Turin

d. Apr. 10, 1813, Paris

Educated at Turin, at the age of eighteen Lagrange became professor of mathematics

there. After winning prizes in Paris for theses on the libration of the moon (1764) and Jupiter's satellites (1766), he went to Berlin as Director of the Academy. He returned to Paris (1787) and became the first professor of geometry at the Polytechnic (1797). Though loaded with distinctions he remained modest and unassuming. A master of analytical method he invented the calculus of variations, and in the mathematics of sound he gave a complete solution of the problem of a vibrating string. He also explained echoes, beats and compound sounds. He contributed to the theory of numbers and of differential equations, and his influence was widespread and important. In later life he suffered from attacks of profound melancholy brought on by overwork. He played an important part in the choice of the new units of measurement decided on by the revolutionists in France. Among his works were *Mécanique analytique* (1788) in which he developed the principles of virtual velocities and least action, *Théorie des Fonctions Analytiques* (1797) and *Leçons sur le Calcul des Fonctions* (1806).

Lalande, Joseph Jérôme Lefrançois de

French astronomer

b. July 11, 1732, Bourc-en-Bresse, Ain

d. Apr. 4, 1807, Paris

After studying law at Paris, Lalande became interested in astronomy through a chance visit to Delisle's observatory. He went to Berlin to make observations of the lunar parallax (while Lacaille was in South Africa on the same mission), and later devoted himself to planetary theory. In 1762 he became professor of astronomy at the Collège de France. In his lifetime his planetary tables were unsurpassed.

Lamarck, Jean Baptiste Pierre Antoine de

Monet, Chevalier de

French naturalist

b. Aug. 1, 1744, Bazentin, Picardy

d. Dec. 18, 1829, Paris

LAMBERT

Educated at a Jesuit college, Lamarck entered the army in 1761 but had to resign owing to ill-health. He turned to medicine and botany, becoming professor of zoology at the Jardin des Plantes (1793-1818). Through his personal idiosyncrasies, for example his four marriages and large family, coupled with a liking for speculation, he was often in difficulties, and was regarded with something approaching contempt by his contemporaries. Nevertheless he made notable contributions to biology, particularly in systems of classification. He was the founder of invertebrate palaeontology, and famous as the promoter of an evolutionary theory which foreshadowed the work of Darwin. He established the facts of variation and stressed the importance of environment. It is not now generally accepted that adaptive variations due to environment are hereditary (his main thesis), but it is very difficult to prove or disprove. He introduced the term *biology* and made it a unified science. The invertebrate classes, Infusoria, Annelida, Crustacea, Arachnida, and Tunicata, were first suggested by him. His main works are *Philosophie Zoologique* (1809) and *Histoire Naturelle des Animaux sans Vertèbres* (1815-22).

Lambert, Johann Heinrich

German mathematician

b. Aug. 26, 1728, Mülhausen

d. Sept. 25, 1777, Berlin

The son of a tailor, Lambert had a struggle to develop his education. From a post of clerk he became a private tutor and finally editor of the Prussian astronomical almanac. In 1768 he wrote a paper in which he proved that π is incommensurable, and in a paper on trigonometry he introduced the hyperbolic functions *sinh* and *cosh*. He also pursued researches in heat, light and colour, and the theorem named after him applies inverse squares to the illumination of a surface. The Lambert is a unit of brightness equal to $1/\pi$ candles per sq. cm.

Lamé, Gabriel

French mathematician

b. July 22, 1795, Tours

d. May 1, 1870, Paris

Educated at Paris Lamé worked in Russia as an engineer before returning to Paris as professor of physics at the École Polytechnique. He investigated elasticity and heat, and introduced new mathematical functions, named after him, to solve problems of temperature equilibrium in ellipsoids. He wrote several books on his particular subject, the last of which was *La Théorie Analytique de la Chaleur* (1861).

Lamy, Claude Auguste

French chemist

b. 1820, Neris, Alliers

d. 1878, Paris

Educated in Paris, Lamy became professor of physics at Lille, and when there in 1862 he isolated thallium (independently of Crookes) and studied its salts. He later became professor of chemistry in Paris.

Land, Edwin Herbert

American inventor

b. May 7, 1909, Bridgeport, Conn.

Educated at Harvard, Land turned to invention in connection with photography and devised a polariser used as a camera filter. He also invented a camera which can take, develop and print a photograph in 50 seconds. He has been engaged on research concerning three-dimensional pictures.

Landis, Walter Savage

American chemist

b. 1881, Pottstown, Pa.

Educated at Lehigh University, Heidelberg and Aachen, Landis eventually went into industrial chemistry as chief technologist to the American Cyanamid Co. He is famous for his work on nitrogen fixation and electric smelting, for which he was awarded the Perkin medal for 1939.

Landsteiner, Karl

Austrian-American biologist

b. June 14, 1868, Vienna

d. June, 1943, New York

An Austrian by birth, Landsteiner was trained at Vienna and Chicago, and went from the post of pathologist at Vienna to the Rockefeller Institute for Medical Research in 1922, where he became

emeritus professor in 1939. He was awarded the Nobel prize for physiology and medicine in 1930 for his discovery of human blood groups (1901) and of factors M and N (1927); and in 1941 with Weiner he further discovered a new blood factor, known as Rh as it was first found in the Rhesus monkey. This is of importance in genetics and serology. In 1908 he was engaged in studying poliomyelitis in monkeys.

Lane, Sir Arbuthnot

English surgeon

b. July 4, 1856, Fort George, Scotland

d. Jan. 16, 1943

One of the most famous surgeons of his time, Lane was the first to join fractures with metal plates instead of wires.

Lange, Carl Georg

Danish psychologist

b. 1834

d. 1900

Noted for his production, concurrently with James, of a theory of emotion, named after them, Lange also wrote a history of materialism. His major work, *Ueber Gemütsbewegungen*, was published in 1887.

Langevin, Paul

French physicist

b. Jan. 23, 1872, Paris

d. Dec. 19, 1946, Paris

Professor at the Sorbonne from 1909, Langevin was an authority on the molecular structure of gases (Brownian movement, etc.) and also did much work on secondary X-rays, relativity and magnetic theory. His theory of magnetism (1905) explained much of Curie's work and accounted for the paramagnetism and diamagnetism of gases. According to his theory the susceptibility of a paramagnetic gas varies inversely as the temperature. He escaped from a Nazi prison to Switzerland.

Langley, John Newport

English physiologist

b. 1852

d. Nov. 5, 1925

Educated at Cambridge, Langley was professor of physiology there from 1903

to 1925, and was the owner and editor of the *Journal of Physiology*. He was elected F.R.S. in 1883. After early work on the drug, pilocarpine, he became famous for his work on the sympathetic ganglionic nervous system, and published *Autonomic Nervous System*, Pt. 1.

Langley, Samuel Pierpont

American physicist

b. Aug. 22, 1834, Roxbury, Mass.

d. Feb. 27, 1906

After being assistant at Harvard College Observatory, Langley became professor of physics and astronomy, and director, Allegheny Observatory, Western University of Pennsylvania, and in 1887, secretary to the Smithsonian Institution. He constructed for the study of the infra-red solar spectrum a bolometer which was capable of detecting temperature differences of the order of 10^{-8} of 1°C . With it he studied the variability of the solar constant of radiation, and the selective absorption of heat energy by the earth's atmosphere. He was able to extend the solar spectrum by 3 octaves in 1881 to 5.3μ (53,000 angstroms). In quite a different field he constructed (1896) a model aeroplane which flew about half a mile before the engine stopped, having exhausted the fuel supply. This was the first mechanical heavier-than-air machine to fly. He later attempted to construct one to carry a man but this failed. His 'aerodrome', as he called it, was steam-driven and is to be seen in the National Museum, Washington.

Langmuir, Irving

American chemist

b. Jan. 31, 1881, Brooklyn, N.Y.

Educated at Columbia and Göttingen, Langley left academic work to join the General Electric Co. (1909-50). He gained the Nobel prize for chemistry in 1932 for his studies in surface chemistry. He was responsible for the introduction of the gas-filled tungsten lamp, and for the use of the atomic hydrogen blowpipe for welding. He also invented a condensation pump for producing high vacua, and with Lewis evolved an atomic theory. He developed also a vacuum tube for fluorescent images

LANKESTER



IRVING LANGMUIR

of sufficient intensity to be photographed (1940); and applied his monomolecular layer method to the measuring of the molecular sizes of viruses and toxins (1941).

Lankester, Sir Edwin Ray

English biologist

b. May 15, 1847, London

d. Aug. 15, 1929, London

Educated at Cambridge and Oxford Lankester became professor of zoology and comparative anatomy at University College, London, and later went to Oxford to a similar post, then to the Royal Institution as professor of physiology. In addition to being a popular exponent of his subject, he did valuable work on the comparative anatomy of animals and on the embryology of Mollusca. Elected F.R.S. in 1875, he was awarded the Copley medal in 1913.

Lanston, Tolbert

American inventor

b. 1844, Troy, Ohio

d. 1913

Lanston was the inventor of the Mono-

type—'a type-forming and composing machine' which has revolutionised the printing processes. His machine was patented in 1887 and became used commercially in 1897.

Laplace, Pierre Simon, Marquis de

French mathematician and astronomer

b. Mar. 28, 1749, Beaumont-en-Auge, Normandy

d. Mar. 5, 1827, Paris

The son of a farm labourer, Laplace became professor of mathematics at the École Militaire at an early age. He was an extreme republican and was for a very short time in 1799 Minister of the Interior, and vice-President of the Senate in 1803. He changed his political adherence with commendable rapidity during the troubles of his time and received honours from both sides. Laplace developed a theory of surface tension based on molecular attraction in the liquid, and in 1783, with Lavoisier, laid the foundations of thermochemistry by experiments on specific heat and heat of combustion. He discovered the invariability of the major axes of the planetary orbits, which discredited Newton's fear that the solar system would degenerate into disorder, explained the motions of Jupiter and Saturn, and solved many of the outstanding mathematical problems of the solar system. His *Traité de Mécanique Céleste* (1799-1825) is a fine systematic generalisation of work on the motion of the solar system. He brought forward the famous nebula theory in which he contended that the solar system was the result of a contracting nebula (*Exposition du Système du Monde*, 1796). The tidal theory, now abandoned, ousted it. He was the discoverer of a famous differential equation since named after him, and made important contributions to the modern theory of probability (*Théorie analytique des probabilités*, 1812; *Essai philosophique sur les probabilités*, 1814).

Lapworth, Charles

Scottish geologist

b. 1842, Farringdon

d. Mar. 13, 1920

At first a schoolteacher at Galashiels,

Lapworth was professor of geology at Birmingham from 1881 to 1913. In 1879 he proposed the name *Ordovician* for the strata between the Cambrian and the Silurian.

Lashley, Karl Spencer

American psychologist

b. June 7, 1890, Davis, W. Va.

Educated at W. Virginia, Pittsburgh and the Johns Hopkins Universities, Lashley worked at several American universities before becoming research professor of neuropsychology at Harvard in 1937. He specialised in genetic psychology and published many papers and monographs on the subject, as well as being associate editor of the *Journal of Psychology*.

Lassell, William

English astronomer

b. June 18, 1799, Bolton

d. Oct. 5, 1880, Maidenhead

An amateur astronomer, Lassell constructed his own telescopes, which were reflectors of high quality. He is said to have amused himself as a child of five by polishing lenses. He discovered Ariel and Umbriel, the two nearest satellites of Uranus, in 1851. He discovered also the satellite of Neptune within a month of the discovery of the planet in 1846, and several hundred nebulae.

Lassone, Joseph Marie François

French chemist and physician

b. July 3, 1717, Carpentras

d. Dec. 8, 1788, Paris

A successful surgeon, Lassone gave up his practice as a result of the shock of noticing just as he was about to insert his scalpel to perform an autopsy that his patient was not yet dead. In 1776 he discovered carbonic oxide (carbon monoxide) by reducing the calx of zinc with charcoal.

Laue, Max von

German physicist

b. Oct. 9, 1879, Pfaffendorf, nr. Coblenz

Educated at Strasbourg, Göttingen and Munich, after being professor of physics at Munich and holding similar posts elsewhere, Laue eventually became director of the Institute for Theoretical Physics at

Berlin in 1919. He was awarded the Nobel prize for physics in 1914 for his work in X-ray analysis. In Munich in 1912 he succeeded in producing interference phenomena from X-rays by using the atoms of a crystal as a grating, thus showing that X-rays are light waves of very short wavelength; the discovery also revealed a fruitful method (Laue method) of investigating crystal structure (*Die Interferenz der Röntgenstrahlen*, 1923). The diffraction pattern of X-rays through a crystal is known as a *Laue pattern*.

Laurent, Auguste

French chemist

b. Nov. 14, 1807, La Folie, Haute Marne

d. Apr. 15, 1853, Paris

A pupil of and for a time assistant to Dumas, Laurent spent most of his life in poverty and eventually died of tuberculosis. He was professor in Bordeaux for eight years and then went to Paris to work with Gerhardt. During his lifetime he was ignored by his French fellow-scientists, as also was Gerhardt. Financial difficulties forced him eventually to become assayer at the Mint where he continued his researches under great difficulties. He influenced Dumas' conception of valency and substitution. In 1832 he discovered anthracene and in 1836 obtained phthalic acid by the oxidation of naphthalene. In 1841 he was able to show that phenol was identical with carbolic acid but different from creosote. In a thesis in 1837 he introduced a new method of classification of organic compounds. He constructed a saccharimeter to determine the strength of a sugar solution by the rotation of the plane of polarisation of transmitted light. With Gerhardt he evolved the nucleus theory of organic radicals; and he gave his name to *Laurent's acid*.

Laval, Carl Gustaf Patrik de

Swedish engineer

b. May 9, 1845, Orsa

d. Feb. 2, 1913, Stockholm

One of the earliest workers on turbines, Laval invented a steam turbine at about the same time as Parsons, and also a cream separator working on centrifugal principles.

LAVERAN

Laveran, Charles Louis Alphonse

French physician

b. June 18, 1845, Paris

d. May 18, 1922, Paris

Educated at Strasbourg, Laveran served as an army physician at the Val-de-Grâce military school of medicine and studied malaria in Algeria from 1878-83. In 1880 he discovered the parasite causing malaria (*hématozoaire*); he did much work also on sleeping sickness and similar diseases. He was awarded the Nobel prize for medicine in 1907, and was honoured by the Pasteur Institute. (See also Sir P. Manson and Sir R. Ross.)

Lavoisier, Antoine Laurent

French chemist

b. Aug. 26, 1743, Paris

d. May 8, 1794, Paris

After studying astronomy, botany and chemistry, and directing the state gunpowder works, Lavoisier became in 1780 Fermier-Général, and after the revolution was a member of the commission which established the metric system (1790), and commissary of the Treasury (1791). In 1794 his former position led to his arrest,

and though guilty of no crime he was executed on a ridiculous charge of having watered the soldiers' tobacco. Such a callous disregard for genius has probably never been equalled. 'La République n'a pas besoin des savants' was the cynical remark of the tribunal sentencing him. Lavoisier's great reputation as the founder of modern chemistry is based on his interpretation of the results of others rather than on his own experimental discoveries. He rounded off the work of Cavendish, Black and Priestley, the latter in particular being singularly backward in drawing the correct conclusions from his experiments. His experiments were strictly quantitative, and he stated the indestructibility of matter. The phlogiston theory received its final dismissal from his work on combustion, in which he realised the function of oxygen, which he claimed to have discovered along with Priestley and Scheele; though the credit definitely belongs to the last-named, Lavoisier certainly gave it its name (see also J. Mayow). He also determined the composition of nitric and sulphuric acid, was the first to make 'water-gas', and invented the gasometer. He introduced a new chemical nomenclature which, accepted by Black, Berthollet and Fourcroy, gradually replaced the older system.



ANTOINE LAURENT LAVOISIER: 'La République n'a pas besoin des savants.'

Lawes, Sir John Bennet, Bart.

English agriculturalist

b. Dec. 28, 1814, Rothamsted, Herts.

d. Aug. 31, 1900, Harpenden, Herts.

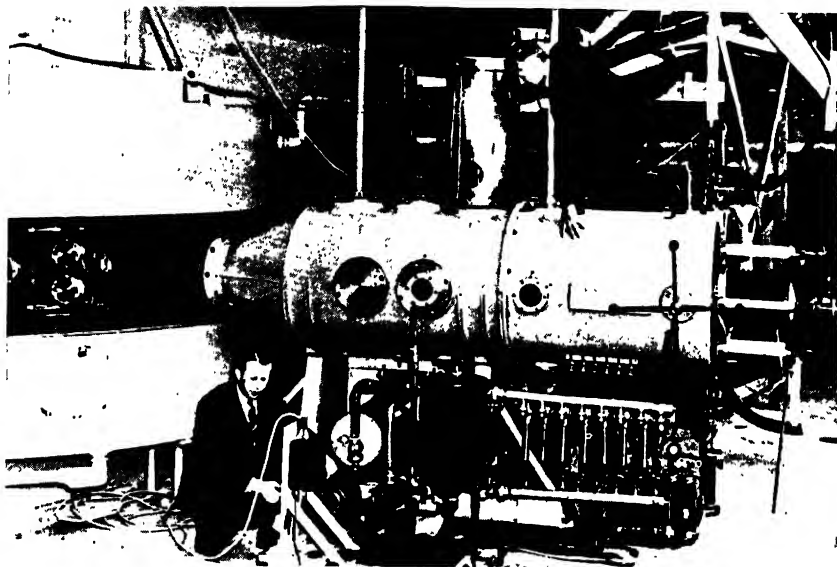
Educated at Oxford, Lawes became interested in experimental agriculture and in 1842 patented a fertiliser, the first superphosphate, thus inaugurating the artificial manure industry. Joining with J. H. Gilbert, he founded and developed the famous Rothamsted station which is now State-aided. He was elected F.R.S. in 1854.

Lawrence, Ernest Orlando

American physicist

b. Aug. 8, 1901, Canton, S. Dakota

Educated at the South Dakota, Minnesota, Chicago and Yale universities, Lawrence became professor of physics at the Uni-



ERNEST ORLANDO LAWRENCE (*below*) makes final adjustments on the 225-ton cyclotron, capable of a 19-million volt beam of deuterons, July, 1939.

versity of California in 1928. In 1930 he built the first cyclotron for the production of high energy particles and used it to study the transmutation of elements and artificial radioactivity. For this work he gained the Nobel prize for physics in 1939. He has also studied the application of atomic radiation to biology and medicine.

Lebedev, Petr Nikolajevich

Russian physicist

b. Feb. 24, 1866, Moscow

d. Mar. 1, 1912

After studying at Strasbourg under Kundt, Lebedev became professor of physics at Moscow in 1892. In connection with experiments on Crookes' radiometer he proved that light exerts a pressure on bodies, and showed that the pressure of the incident light is twice as great for reflecting as for absorbent surfaces.

Leblanc, Nicolas

French chemist

b. 1742, Issoudun, Indre

d. Jan. 10, 1806, St. Denis, Seine

Trained in medicine, Leblanc practised as a surgeon, but later turned to chemistry. In 1791 he invented the well-known process which bears his name, for the production of sodium carbonate from common salt. The process is no longer used but was very important at the time. The financial failure of his works, owing largely to the revolution, caused him to commit suicide.

Le Chatelier. See Chatelier, Henry Le.

Leclanché, Georges

French chemist

b. 1839, Paris

d. 1882

An otherwise undistinguished chemist, he is remembered as the inventor of the well-known galvanic cell named after him.

Lécluse, Charles de (or Lescluse, Lat. Clusius)

French botanist and traveller

b. Feb. 18, 1524 or 1525, Arras

d. April 4, 1609, Leyden

Remembered by name in the genus of trees,

LEEUEWENHOEK

Clusla, L  cluse is credited by some with having introduced the potato into Europe. He mentioned it in a book in 1588 but general opinion favours Cardan's claim.

Leeuwenhoek, Anton van

Dutch microscopist

b. Oct. 24, 1632, Delft

d. Aug. 26, 1723, Delft

Starting as a shop assistant, Leeuwenhoek soon took up microscopy and using simple lenses to avoid chromatic aberration made many instruments, some of which he gave away. He did not specialise, being interested in every branch of nature under the microscope, but among his original observations were the shapes of blood corpuscles, the study of tissues (in which he detected starch granules) and the lens of the eye, especially the compound insect eye. He was the first to note that the aphid reproduces parthenogenetically, that is without a male, and also the first to see micro-organisms, with a simple lens which he made himself. In 1679 he was also the first to describe the spermatozoa of mammals, though it was not until 1879 that the Swiss biologist Hermann Fol saw one actually penetrate an ovum.

Legendre, Adrien Marie

French mathematician

b. Sept. 18, 1752, Toulouse

d. Jan. 10, 1833, Paris

Educated at Paris, Legendre became professor of mathematics at the military academy there, and played a prominent part in the measurement of a degree of latitude between Dunkirk and Boulogne. He was forced into comparative obscurity by the hostility of Laplace, though his work on elliptic functions (1827) was outstanding, and his treatise on the theory of numbers (1798) remains a classic, enunciating as it does the law of quadratic reciprocity. The method of least squares also received his attention, and he published a text-book of geometry (1794).

Leibniz, Gottfried Wilhelm, Baron von (also Leibnitz)

German mathematician and philosopher

b. July 1, 1646, Leipzig

d. Nov. 14, 1716, Hanover

Leibniz studied law, mathematics and philosophy at Leipzig and in the course of a long life met many scholars and published many books on a wide range of subjects. On visiting England he became a member of the Royal Society and associated with Newton, a fact which later led to a controversy as to their claims to have invented the differential calculus. Leibniz certainly invented the modern notation which is much superior to Newton's, but the question as to whether he borrowed Newton's ideas during his development of the calculus has never been settled. He was an active politician in the service of the Hanoverians (1676-1716) but was dishonoured and neglected in the last two years of his life after the accession of George I to the throne of England. His lack of scruples in politics may have inclined his critics to the possibility of similar behaviour in the realm of mathematics, but modern authorities tend to clear him of any suspicion of plagiarism. As a philosopher he invented the elementary, self-existent *monads* to form a world whose harmony was to justify his philosophical Optimism. His writings were scattered among casual papers, essays and letters. See Bertrand Russell, *Critical Exposition of the Philosophy of Leibniz* (1900).

Leishman, Sir William Boog

Scottish bacteriologist

b. Nov. 6, 1865, Glasgow

d. June 2, 1926, London

Educated at Glasgow, Leishman became professor of pathology in the Army Medical College. He discovered the vaccine which proved successful for inoculation against typhoid. In 1924 he became Director-General, Army Medical Service.

Leith, Charles Kenneth

American geologist

b. Jan. 20, 1875, Trempealeau, Wisconsin

Educated at Wisconsin and Columbia, Leith became professor of geology at Wisconsin in 1903, and adviser on mineral resources to the American government. He has made estimations of the percentage of shales, sandstones and limestones in sediments.

Lemaître, Abbé Georges Édouard
Belgian astrophysicist
b. 1894

Professor of the theory of relativity at Louvain, Lemaître is an authority on that subject and on its application to the theory of the expanding universe.

Lemonnier, Pierre Charles

French astronomer

b. Nov. 23, 1715, Paris

d. May 31, 1799, Héril, nr. Bayeux

Gaining membership of the Academy of Sciences at the age of twenty through his lunar map, Lemonnier did much to improve astronomical measurement in France. He introduced the more modern English instruments and methods, including the transit instrument at the Paris Observatory, and himself made many planetary observations. In the course of star plotting he made no less than twelve observations of Uranus before it was recognised as a planet. He recorded the influence of Saturn on the orbit of Jupiter, and did much work on terrestrial magnetism and atmospheric electricity.

Lenard, Philipp E. A. von

German physicist

b. June 7, 1862, Pozsony (Bratislava)

d. May 20, 1947

Educated at Heidelberg under Bunsen, Lenard eventually became professor of physics there (1896-98 and 1907-31), and was awarded the Nobel prize in 1905. He is noted for his original research on cathode rays, in the course of which he made a small aluminium window in the side of a vacuum tube and thus measured the penetration of cathode rays in the atmosphere. He was the author of several books on cathode rays, relativity and related subjects. Another of his researches was an elucidation of the theory of phosphorescence. He was an ardent supporter of Nazi theories.

Lennard-Jones, Sir John Edward

English chemist and physicist

b. Oct. 27, 1894

Educated at Manchester and Cambridge, Lennard-Jones occupied professorial chairs

in physics and mathematics at Bristol before becoming professor of theoretical chemistry at Cambridge in 1932. He worked for the government as Key Scientist during the late war. He has done much research on surface chemistry, the chemistry of carbon, liquid structure and interatomic forces.

Lenoir, Jean Joseph Étienne

French inventor

b. 1822

d. 1900

One of the many inventors who contributed to the development of the motor-car, Lenoir constructed an internal combustion engine about 1859 and a small car in 1860.

Lenz, Heinrich Friedrich Emil

German physicist

b. Feb. 2, 1804, Dorpat

d. Feb. 10, 1865, Rome

As professor of physics at St. Petersburg, Lenz did research on the conductivity of materials and its relation to temperature. He discovered the law relating heat and current usually known as Joule's Law, and also Lenz's law governing induced current.

Leslie, Sir John

Scottish physicist and mathematician

b. Apr. 10, 1766, Largo, Fifeshire

d. Nov. 3, 1832, Coates, Fifeshire

After studying at St. Andrews and Edinburgh for the church, Leslie gave up the church for science, becoming professor of natural philosophy at Edinburgh in 1819. He constructed a differential air-thermometer which is useful for experiments on radiation, and a hygrometer (1800); and was the author of several books.

Levene, Phoebe Aaron Theodore

American chemist

b. Feb. 25, 1869, St. Petersburg

d. Sept. 6, 1940

Of Russian birth, Levene went to America in 1892, having been educated at a military school at St. Petersburg. He studied chemistry at many continental universities and at Columbia, and in 1905 went to the Rockefeller Institute. He did notable work

LEVERRIER

in biochemistry e.g. on proteins, hexosamines, stereochemistry, etc.

Leverrier, Urbain Jean Joseph

French astronomer

b. Mar. 11, 1811, Saint-Lô, Normandy

d. Sept. 23, 1877, Paris

After having conducted chemical research, Leverrier turned to astronomy, and became a member of the Academy of Sciences through his observations on the transit of Mercury in 1845. His study of the irregularities in the motion of Uranus led to the discovery of Neptune, but though his results were those used by Galle in Berlin in his actual discovery, it was recognized that Adams in England had obtained the same results a little ahead of Leverrier. They share the honour of the discovery. Leverrier's arrogance and violence of temper were a handicap to him in public life.

Lewis, Gilbert Newton

American chemist

b. 1875

d. 1946

A co-worker with Langmuir, Lewis collaborated in developing an atomic theory which is named after them. Lewis also produced a theory of valency (the electrovalent bond) and of photons, and did notable work on thermodynamics. He was a professor at the University of California from 1912.

Lewis, Warren Kendall

American chemist

b. Aug. 21, 1882, Laurel, Delaware

Educated at the Massachusetts Institute of Technology and at Breslau, Lewis eventually became professor of chemical engineering at the former. He has done notable work on the thermal properties of materials, and on colloids.

Libavius, Andreas (Ger. Libau)

German chemist

b. 1540?

d. 1616

A German schoolmaster, Libavius studied chemistry and wrote the first text-book on the subject. Although a believer in trans-

mutation, he made some useful experiments and discovered stannic chloride.

Lie, Marius Sophus

Norwegian mathematician

b. Dec. 17, 1842, Nordfjordeif, nr. Bergen

d. Feb. 18, 1899, Christiania (Oslo)

Educated at Christiania (Oslo) University, Lie became assistant tutor there, and in 1872 professor of mathematics. In 1886 he went to Leipzig as professor of mathematics but returned to Christiania in 1898. He is famous for his theory of tangential transformations, in particular his transformation making a sphere correspond to a straight line. His greatest publication was *Theorie der Transformationsgruppen* (1893).

Liebig, Justus, Baron von

German chemist

b. May 12, 1803, Darmstadt, Hesse

d. Apr. 18, 1873, Munich

After studying at Bonn and Erlangen and later in Paris with Gay-Lussac, Liebig became in 1824 professor of chemistry at Giessen, and in 1852 went to Munich. His teaching of practical chemistry and his laboratory at Giessen were world-famous. His laboratory, opened eight years after that of Thomas Thomson, was the first students' laboratory on the Continent. A man of strong morality, his unflinching honesty caused him to be rather outspoken in his criticisms. He was a great worker in organic chemistry, particularly in organic analysis, and experimented also in physiological chemistry, in, for example, the production of fat, meat extract and other substances. He was the first to realise that animal heat is due to the combustion of food, and the first to divide food into fats, carbohydrates and proteins. In 1832 he found that meat extract contained lactic acid. Among his many discoveries was a method of silvering mirrors (1856), and he also invented the well-known condenser which carries his name. In 1831 he produced chloroform by the action of chlorine on alcohol with caustic alkali, and he deduced the existence of the benzoyl radical (see Wöhler). He introduced artificial fertilisers into agriculture and taught that plants absorb minerals from

the soil and carbon and nitrogen from the atmosphere. See W. A. Shenstone, *Justus von Liebig; His Life and Work* (1895).

Linacre, Thomas

English physician and scholar

b. c. 1460, Canterbury

d. Oct. 20, 1524

Educated at Oxford and in Italy at Padua, Linacre became Henry VII's physician, and was instrumental in founding the College of Physicians, of which he was the first president. Among his pupils were Erasmus and Sir Thomas More as well as the royal children, and he translated Galen, Proclus (astronomy) and Aristotle, the last named translation being now lost. The Linacre professorship in anatomy at Oxford is a memorial of his foundation of a readership in medicine at that university. With Colet he was responsible for the introduction to England of the New Learning, and wrote on Latin grammar (1523, 1524). See Dr. Noble Johnson, *Life of Thomas Linacre* (1835).

Lind, James

Scottish physician

b. 1716, Edinburgh

d. July 13, 1794, Gosport, Hampshire

Educated at Edinburgh, Lind was physician to a naval hospital and did more than anyone else in his time to improve the conditions of health of sailors. He reintroduced lemon juice as a scurvy preventative, and also worked on the distillation of sea-water and on typhus.

Lind, Samuel Colville

American chemist

b. June 15, 1879, McMinnville, Tenn.

After studying at the Washington and Lee universities, the Massachusetts Institute, Leipzig, Paris and Vienna, Lind held many high academic posts and eventually became director of the school of chemistry at Minnesota (1926) and Dean of the Institute of Technology there (1935). He did much research on radioactivity and photochemistry, invented an electroscope, named after him, for radium measurements, and evolved the ionisation theory of the chemical effects of radium rays.

Linde, Karl von

German chemist

b. June 11, 1842, Berndorf

d. Nov. 16, 1934, Munich

In 1895 Linde constructed apparatus by which air could be liquefied on a commercial scale, the operation taking fifteen hours. Later Dewar reduced this time to sixteen minutes.

Lindemann, F. A. See Cherwell, Baron

Linnaeus, Carolus (Swed. Carl von Linné)

Swedish botanist

b. May 23, 1707, Råshult, Småland

d. Jan. 10, 1778, Uppsala

The son of a clergyman, and backward as a boy, Linnaeus was educated as a medical student at the University of Lund. After travelling and holding various positions, he became professor of medicine (1741) and botany (1742) at Uppsala, and is recognised as the father of precise biological classification. His system of classification though purely artificial was a great advance on anything previous, though it has been modified in recent times. In 1732 he went on a visit to Lapland as a collector, and travelled between four and five



CAROLUS LINNAEUS

LIPPMANN

thousand miles for £25, discovering a hundred new plant species. On his death his collection was bought and removed to England where it became the property of the Linnean Society. It is said that the King of Sweden made a last-minute effort to prevent its removal but that the British ship carrying it proved too fast for its pursuer. Linnaeus was the author of several important books, of which *Systema Naturae* (1737) announced his system of specific names in the 10th ed. (1758). His other books, giving the results of his travels and researches, include *Hortus Cliffortianus* (1737), *Genera Plantarum* (1737), *Critica Botanica* (1737), describing his system of sexual classification, *Classes Plantarum* (1738), *Flora Suecica* and *Fauna Suecica* (1748), *Philosophia Botanica* (1751) and *Species Plantarum* (1753).

Lippmann, Gabriel

French physicist

b. Aug. 16, 1845, Hollerich, Luxembourg

d. July 31, 1921, at sea

Educated at Paris and in Germany, Lippmann eventually became professor of mathematical physics and experimental physics at the Sorbonne (1886). He was

awarded the Nobel prize for physics in 1908, having been elected F.R.S. in the same year. The inventor of a capillary electrometer named after him, he experimented with colour photography, and, using laminated films, produced the first coloured photograph of the spectrum. He predicted the phenomenon of piezoelectricity which was later demonstrated by Pierre Curie.

Lissajous, Jules Antoine

French physicist

b. 1822

d. 1880

Professor at the Collège St. Louis, Paris, Lissajous invented in 1857 the vibration microscope which shows visually the resultant of two simple harmonic motions at right angles to one another. These are known as Lissajous' figures. He is also known for his work on acoustics and optics.

Lister, Joseph, Baron

English surgeon and scientist

b. Apr. 5, 1827, Upton, Essex

d. Feb. 10, 1912, Walmer, Kent

Educated at London, Lister held many high academic posts in medicine before becoming professor of clinical surgery at King's College, London. He is famous for his introduction of antiseptics, which revolutionised surgery. Following on Pasteur's work, he studied sepsis and supuration, and introduced carbolic acid as a germicide with complete success. He found that whereas he had previously lost 43% of his patients undergoing amputations, he now lost only 15%. He became president of the Royal Society and of the British Association. It was his father, Joseph Jackson Lister (1786-1869), wine merchant, who discovered the aplastic principle of the modern microscope and determined the shape of red blood corpuscles. See Sir R. J. Godlee, *Lord Lister* (1920).

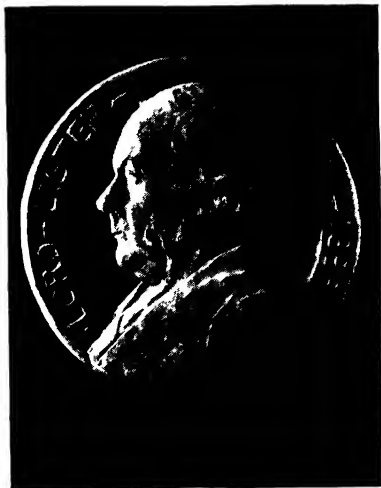
Liston, Robert

Scottish surgeon

b. Oct. 28, 1794, Ecclesmachan, Linlithgow

d. Dec. 7, 1847, London

Educated at Edinburgh, Liston became



JOSEPH LISTER whose "puffing Billy" (carbolic acid spray) was the beginning of the modern revolution in surgery.

one of the greatest surgeons of his time. It is said that he was one of the 'resurrectionists' who robbed graves for anatomical material. He has the distinction of being the first surgeon in England to perform an operation under ether, at University College Hospital in 1846, where he had become professor of surgery in 1835. He devised *Liston's splint* for thigh dislocations.

Lloyd, Humphrey

Irish scientist

b. April 16, 1800, Dublin

d. Jan. 17, 1881, Dublin

Educated at Dublin, Lloyd became provost at Trinity College there, and was president of the British Association in 1857. He discovered a method of producing interference fringes with a single mirror, and conducted experiments on internal conical refraction. In this connection he verified the predictions of Sir W. Hamilton concerning the production of a hollow cylinder of rays by internal conical refraction in biaxial crystals.

Lobachevski, Nikolai Ivanovich

Russian mathematician

b. Oct. 11, 1793, Nijni-Novgorod

d. Feb. 24, 1856, Nijni-Novgorod

Lobachevski was a professor of mathematics (1816-56) and later rector at Kazan University, where he was educated. He is remembered in the annals of mathematics as the originator of the first comprehensive system of non-Euclidean geometry (first conceived by Gauss). About the same time, and independently, Bolyai (q.v.) was working towards similar formulae. Both systems started from Euclid's disputed Postulate V, Bk. I (axiom of parallels) and were confined to hyperbolic non-Euclidean space. (See also Riemann.) Among Lobachevski's works are *Principles of Geometry* (1829-30), *Imaginary Geometry* (1835), *New Principles of Geometry* (1835-38), all translated into German, and *Untersuchungen zur Theorie der Parallelinien* (Berlin, 1840).

L'Obel, Matthias de (also Lobel)

Flemish naturalist

b. 1538, Lille

d. Mar. 2, 1616, Highgate

L'Obel was one of the earliest botanists to classify plants by their structure, though his use of leaf forms as a basis led to peculiar results in that quite unrelated plants became classed together. He became botanist and physician to James VI and I, and gave his name to the *Lobelia*.

Lockyer, Sir Joseph Norman

English astronomer

b. May 17, 1836, Rugby

d. Aug. 16, 1920, Sidmouth, Devon

Beginning as a clerk in the War Office, Lockyer became professor at the Royal College of Science in 1881 and later director of the solar observatory at Kensington. He was director of several eclipse expeditions, and in 1869, when he was elected F.R.S., he founded the scientific journal *Nature*. In 1903 he was president of the British Association. In 1868, at the same time as Janssen, Lockyer discovered and named the chromosphere and pointed out a method of viewing it with a spectroscope. He was a pioneer in the application of the spectroscope to the sun. With Frankland, he discovered helium in the sun's atmosphere, from spectrographic observations during the eclipse of 1868. He was the first to show that the spectral lines of a substance give an indication of its temperature as well as its constitution, and was the author of several books and papers on astronomy.

Lodge, Sir Oliver Joseph

English physicist

b. June 12, 1851, Penkhull, Staffs.

d. Aug. 22, 1940

Educated at University College, London, Lodge passed from the post of reader in natural philosophy at Bedford College for Women to that of assistant professor of applied mathematics at University College, London, finally becoming the first professor of physics at Liverpool, and later principal of Birmingham University. Well-

LOEB

known for his work on electricity, including wireless telegraphy, he wrote a great many books on science, both popular and technical. An F.R.S. in 1902, he was president of the British Association, and later became strongly interested in psychical research, being a believer in the possibility of communicating with the dead. He conducted researches into electromagnetic radiation, ether drag, lightning and other subjects. With his *coherer* (as he named it) he studied Hertzian waves, evolving a system of wireless telegraphy before Marconi.

Loeb, Jacques

German-American biologist

b. Apr. 7, 1859, Mayen, Germany

d. Feb. 11, 1924, Hamilton, Bermuda

Educated at Berlin, Munich and Strasbourg, after working first at Strasbourg and later at Chicago Loeb eventually went to the University of California (1902-10) and finally became head of the general physiology division at the Rockefeller Institute for Medical Research (1910-24). His work on the distinction between living and dead matter eventually led him in 1899 to the remarkable discovery that some eggs could be fertilised by artificial treatment, for example by pricking with a needle dipped in blood, an example of artificial parthenogenesis. He also announced a theory of tropism and taxis, and was the author of several books.

Loewi, Otto

German pharmacologist

b. June 3, 1873, Frankfort-on-Main

Educated at Strasbourg and Munich, he was professor of pharmacology at Graz from 1909 to 1938, and then research professor of pharmacology at New York University College of Medicine (1940). Working with Dale, he shared with him the Nobel prize for medicine in 1936 for investigations on nerve impulses and their chemical transmission.

Lombroso, Cesare

Italian psychiatrist

b. Nov. 18, 1836, Verona

d. Oct. 19, 1909, Turin

After studying at Padua, Vienna and Paris,

Lombroso became interested in the connection between disease and criminology and eventually became professor of criminal anthropology at Turin. He is noted for his remarkable researches into the medical peculiarities of criminals as an anthropological class, and perhaps tended too much to regard all classes of criminality as disease to the exclusion of other causes. *L'Uomo Delinquente* (1876) is his greatest work.

Long, Crawford Williamson

American physician

b. Nov. 1, 1815, Danielsville, Ga.

d. June 16, 1878, Athens, Ga.

Educated at Transylvania University and Pennsylvania, Long was the first to perform an operation with ether. In 1842 he cut out a tumour from the neck of a boy but did not publish his discovery until 1849. This delay in publication led to a controversy as to who should have the honour of the discovery, the U.S. government having offered \$100,000 to the inventor. The award was never made though Long was probably the strongest claimant.

Lonsdale, William

English geologist

b. Sept. 9, 1794, Bath

d. Nov. 11, 1871, Bristol

After serving in the army Lonsdale took up geology on his retirement in 1815. He studied the fossils in north and south Devon, and in 1837 placed them between the Silurian and Carboniferous. This led to the establishment of the Devonian System by Murchison and Sedgwick in 1839.

Lorentz, Hendrik Antoon

Dutch physicist

b. July 18, 1853, Arnheim

d. Feb. 4, 1928, Haarlem

Educated at Leyden, Lorentz became professor of mathematical physics there in 1878. He was an authority on the quantum theory and the discoverer, independently of Fitzgerald, of the contraction which is known by their names. His researches in electromagnetism prepared the way for the

theory of relativity, the Lorentz transformation being a necessary step in its development. This transformation provides formulae for the variations in space and time measurements for systems in relative motion. These formulae offer mathematical confirmation of the Lorentz-Fitzgerald contraction. He also did work on gravitation, thermodynamics, radiation and kinetic theory, and he provided an explanation of the Zeeman effect. With Zeeman he was awarded the Nobel prize for physics in 1902. In 1906 he was attached to Columbia University, and from 1912-13 to the Collège de France. He made two expeditions to New Guinea (1907, 1909).

Loschmidt, Joseph

Austrian physicist

b. Mar. 15, 1821, Putschirn

d. July 8, 1895, Vienna

Loschmidt was a schoolmaster, and the first to calculate the number of molecules in a cubic centimetre of gas at 0°C. and atmospheric pressure. This, known as the Loschmidt number, is $2.687 \cdot 10^{19}$.

Lowell, Percival

American astronomer

b. Mar. 13, 1855, Boston

d. Nov. 12, 1916, Flagstaff, Arizona

Educated at Harvard, Lowell established the Flagstaff Observatory in Arizona in 1894. He is famous for his observations of Mars and even more so for his anticipation of the existence of Pluto which was discovered by his successors at the Flagstaff Observatory roughly in the place where he had expected it. He was convinced of the presence of life on Mars, and wrote several books on astronomy and on Japan.

Lowig, Carl

German chemist

b. 1803, Kreuznach, Prussia

d. 1890, Breslau

Educated at Heidelberg under Gmelin, Lowig became professor of chemistry at Zürich and later at Breslau. In 1825 he prepared a small quantity of bromine, but

before he could produce more for a complete examination Balard announced the discovery of this new element, thus gaining the credit. Lowig did, however, publish a monograph on the properties of the substance and its compounds.

Ludwig, Karl Friedrich Wilhelm

German physiologist

b. Dec. 29, 1816, Witzenhausen, nr. Cassel

d. 1895, Leipzig

After studying medicine at Erlangen and Marburg, Ludwig eventually became professor of physiology at Leipzig. He was the inventor of the mercurial blood-gas pump which enables us to separate the blood from the mixture of gases in it and so analyse them. This led to an understanding of the part played by oxygen and other gases in the purification of the blood stream. He investigated glandular secretions and the part played by the nervous system in circulation.

Lumière, Louis Jean

French chemist and industrialist

b. 1864, Besançon; *d.* 1948, nr. Toulon

With his brother, Auguste Marie Louis Nicolas (1862-1953), Lumière manufactured photographic materials. They invented a process of colour photography, named after them, and were pioneers in the film industry, inventing in 1893 a camera for motion pictures. They propounded also an explanation of life in terms of colloids. See Friese-Greene

Lummer, Otto R.

German physicist

b. July 17, 1860, Jena

d. July 5, 1925, Breslau

Professor at Breslau from 1905, with Brodhun in 1889 Lummer designed a photometer using an arrangement of prisms; and with Arons he constructed a mercury vapour lamp to produce monochromatic illumination. He conducted with Pringsheim a series of important experiments on radiation energy and temperature, confirming several theoretical laws. Their work on black body radiation led Planck to the quantum theory.

LYELL

Lyell, Sir Charles

Scottish geologist

b. Nov. 14, 1797, Kinnordy, Forfar

d. Feb. 22, 1875, London

Educated at Oxford, Lyell became a lawyer but abandoned the Bar to take up geology; he was elected F.R.S. in 1826. In 1832 he was the first professor of geology at King's College, London, and became president of the Geological Society in 1836 and 1850, and of the British Association in 1864. He became blind in later life. In 1829 he subdivided the Tertiary system into Eocene, Miocene and Pliocene. In 1839 he introduced the further division, the Pleistocene. His *Principles of Geology* (1830-33) denied the explanation of geological change offered by catastrophism, and may be to a large extent regarded as founding modern geology.

Lysenko, Trofim Denisovich

Soviet biologist

b. Sept. 29, 1898, Karlovka, Ukraine

A member of the U.S.S.R. Academy of

Sciences, and, since 1940, president of the All-Union Academy of Agricultural Sciences, Lysenko has developed and ensured the prevalence in Russia of the theories of Ivan Michurin. He has studied mainly the practical application of genetics to agriculture and evolved the method of vernalisation, whereby winter seed whose germination has been retarded by freezing may be sown as spring seed. His claim to have established the inheritability of acquired characters roused widespread controversy and opposition among the more orthodox Mendelian school. Under his leadership Soviet genetics has also emphasised Michurin's ideas on vegetative hybridisation (the production by a grafted host of seed possessing characters of both scion and host), the influencing and improving of plants by grafted 'mentors', the breeding of grafted plants and the breeding of fertile intergenal hybrids. Lysenko was awarded the Order of Lenin in 1948 and a Stalin prize for his book *Agrobiology* (1948), but in 1954 appeared to lose some of his influence.

M

Maanen, Adriaan van

Dutch-American astronomer

b. Mar. 31, 1884, Sneek, Holland

d. Jan. 26, 1946

In 1911 van Maanen became assistant at Yerkes Observatory and in 1912 at Mt. Wilson Observatory. He tried to show by photographic comparisons that nuclear matter does actually flow along the arms of spiral nebulae. For M 81 in Ursa Major a rotational period of about 58,000 years resulted ; his results are not accepted.

McCollum, Elmer Verner

American physiological chemist

b. Mar. 3, 1879, Fort Scott, Kansas

Educated at Kansas and Yale, he became professor at Wisconsin in 1913, and in 1917 professor of biochemistry at the Johns Hopkins University. He did much research work on nutrition and growth, and wrote several text-books on the subject, e.g. *Foods, Nutrition and Health* (1933 and 1940).

Mach, Ernst

Austrian physicist and philosopher

b. Feb. 18, 1838, Turas, Moravia

d. Feb. 19, 1916, nr. Munich

After studying at Vienna he became professor of mathematics at Graz (1864), and of physics first at Graz (1866), then Prague (1867), and of philosophy at Vienna (1895-1901). Mach studied physics, and the physical and psychological problems of the physiology of the senses, especially in connection with epistemology. In pure physics he did remarkable pioneer work on supersonic projectiles and jets, and in 1887, in a paper on 'Photography of Projectile Phenomena in Air,' described the Mach angle (between the axis of the projectile and the envelope of the waves produced) on which the conception of Mach number is based :

$$v/\omega = \sin \alpha,$$

where v = velocity of sound and ω =

velocity of projectile. This ratio is of cardinal importance in problems of supersonic flight. Mach's work on epistemology founded the philosophy of Empirio-kritizismus, based on the analysis of experience data and postulating that the conditions of every physical phenomenon are physical phenomena (Mach's postulate). This denial of the 'absolute' conception led to logical positivism, and influenced Einstein.

Mackenzie, Sir James

Scottish physician

b. Apr. 12, 1853, Scone, Perthshire

d. Jan. 26, 1925, London

Educated at Perth and Edinburgh, Mackenzie became a physician at Bursley (Lancs.) and later at London. He was elected F.R.S. in 1915. He was an authority on the heart, apart from original work on shingles (*herpes zoster*), and he invented the polygraph to record graphically the heart's action. *Diseases of the Heart* was published by him in 1908.

Maclaurin, Colin

Scottish mathematician

b. Feb., 1698, Kilmodan, Argyllshire

d. June 14, 1746, York

Educated at Glasgow, at nineteen Maclaurin became professor of mathematics at Aberdeen and in 1719 was elected F.R.S. In 1725 he became professor at Edinburgh. His salary at the latter place while he was deputy professor was paid privately by Newton. After taking an active part in opposing the Young Pretender in 1745, he was obliged to fly to York, and the rigours of the campaign and escape proved too much for his constitution. He wrote *A Treatise of Fluxions* (1742) in which he developed Newton's method of presenting the calculus but in so doing perhaps held back the progress of mathematics in England rather than aided it. He developed a theorem named after him, which can be

McLENNAN

deduced from Taylor's theorem; and wrote *An Account of Sir Isaac Newton's Philosophy* (1748).

McLennan, John Cunningham

Canadian physicist

b. 1867

d. 1935

Professor at Toronto from 1907 to 1931, McLennan did much original work on electricity in connection with superconductivity of metals. He succeeded in liquefying helium in 1932. With Shrum he obtained a spectrum similar to that of the aurora by passing electrons through thin oxygen.

Macleod, John James Rickard

Scottish physiologist

b. Sept. 6, 1876, Cluny, nr. Dunkeld, Perthshire

d. Mar. 16, 1935, Aberdeen

Educated at Aberdeen, Leipzig and Cambridge, after being lecturer in biochemistry at the London Hospital (1899-1902), he became professor of physiology at Cleveland, Ohio (1903), and then at Toronto, and finally (1928) at Aberdeen. In 1922 with Banting and Best he discovered insulin, which has proved so helpful in the treatment of diabetes. He was elected F.R.S. in 1923 and in that year shared the Nobel prize with Banting. He was the author of several books on physiology.

Macquer, Pierre Joseph

French chemist

b. Oct. 9, 1718, Paris

d. Feb. 15, 1784, Paris

The writer of a famous chemical dictionary (1766) and one of the first chemists to study platinum, he was the discoverer of the arsenates of potassium and sodium. He was also the first to notice the formation of water drops on a cold surface touched by a hydrogen flame.

Mädler, Johann Heinrich

German astronomer

b. May 29, 1794, Berlin

d. Mar. 14, 1874, Hanover

Educated as a teacher, Mädler had a hard struggle to save enough money to study

astronomy at Berlin. One of his pupils, Wilhelm Beer, a wealthy banker, became so interested in astronomy as to build his own observatory in which pupil and teacher worked together for many years. Mädler's work gained him the position of director of the Dorpat Observatory, following Struve, and he stayed there twenty-five years (1840-65). From observations between 1830 and 1837 he and Beer produced the first reliable map of the moon, using a 3 $\frac{1}{2}$ inch telescope. They also, in 1840, produced the first map of Mars. He made the first effort to find the centre of the universe by using the available proper motions of stars. He placed it in π Taurus near the star Alcyone but it was later shown that his premises were faulty.

Magendie, François

French physiologist

b. Oct. 15, 1783, Bordeaux

d. Oct. 7, 1855, Sannois, nr. Paris

After studying in Paris, Magendie became professor of pathology in the Collège de France. He was noted for his experimental work on the motor and sensory functions of the spinal roots, and in general for his work on the physiology of food. He introduced bromine, iodine, strychnine and morphine compounds into general medical use. He suffered rather undeserved criticism as a vivisectionist, though it is true that he performed many experiments on living animals.

Malinowski, Bronislaw Kasper

Polish anthropologist

b. Apr. 7, 1884, Cracow

d. May 16, 1942, New Haven, Conn.

Educated at the Polish University, Malinowski studied social anthropology and did research in New Guinea from 1914 to 1920. He became professor at London University in 1927 and at Yale in 1939. His works include *Sex and Repression in Savage Society* (1927) and *The Sexual Life of Savages in N.W. Melanesia* (1929).

Malpighi, Marcello

Italian physician and anatomist

b. Mar. 10, 1628, Crevalcuore, nr. Bologna

d. Nov. 30, 1694, Rome

Malpighi studied philosophy and medicine at Bologna and became professor of medicine there. In 1661 he discovered the capillary vessels which connect arteries with veins, and he applied the microscope to embryology, making many important discoveries. His treatise on the silkworm was the first monograph on an invertebrate. He was the first to observe the stomata of plants but did not understand their use, described the structure of the human lung, brain and spinal cord, and discovered *Malpighi's layer* in the epidermis, the *Malpighi corpuscles* in the spleen, *Malpighi tufts* (of capillaries) in the kidney, and understood the nature of red blood corpuscles and muscle cells. He made a significant study of the secreting glands and described their structure, and gave a full account of the development of the chick. He may be regarded as the founder of microscopic anatomy.

Malus, Étienne Louis

French physicist

b. June 23, 1775, Paris

d. 1812

An army instructor, Malus saw much service as an engineer, and his loss to science through an early death was due to the rigours of campaigning. He discovered the polarisation of light by reflection and also the law named after him which states that for polarised light the sum of the intensities of the transmitted rays is equal to the intensity of the incident ray. He was the author of a paper explaining the theory of double refraction in crystals (1810) which won him the Institute's prize.

Manchot, Wilhelm

German chemist

b. 1869

After study at Strasbourg and Munich, Manchot held posts at Halle, Göttingen and Würzburg before becoming professor of inorganic chemistry at Munich. He did research on the metal carbonyls, nitrosyls and auto-oxidation.

Manson, Sir Patrick

Scottish bacteriologist

b. Oct. 3, 1844, Aberdeenshire

d. Apr. 9, 1922, London

Educated at Aberdeen, Manson spent twenty-four years in China, where he studied tropical disease and founded the medical school which became the University of Hong-Kong. He was the first to prove the connection between insects and tropical disease by his demonstration of the carrying of embryo *Filaria* by the culex mosquito (see C. L. A. Laveran and Sir R. Ross). He founded the London School of Tropical Medicine (1899), and is regarded as having placed that science on its modern footing.

Marconi, Marchese Guglielmo

Italian inventor

b. Apr. 25, 1874, Bologna

d. July 20, 1937, Rome

Son of an Italian father and Irish mother, Marconi studied under Hertz, and though not the discoverer of wireless telegraphy he stands alone as the producer of the first apparatus to succeed in sending messages through space on a commercial scale. Applying the results of Maxwell, Hertz and others, after experiments at Bologna he succeeded in England in 1896 in sending messages over distances up to nine miles. He founded Marconi's Wireless Telegraph Co. Ltd. in London (1897) and in 1901 he at last sent a message across the Atlantic from Cornwall to Newfoundland. Later his inventions turned towards directional wireless and the system of beam transmission. The Marconi Company's station at Chelmsford was one of the first to broadcast commercially (1920). He shared with Braun the Nobel prize for physics in 1909. See J. de Boinod, *Marconi, Master of Space* (1936).

Marggraf, Andreas Sigismund

German chemist

b. Mar. 3, 1709, Berlin

d. Aug. 7, 1782, Berlin

After studying at Berlin, Strasbourg, Halle and Freiberg, Marggraf was a pupil of Neumann. An outstanding analytical chemist, he isolated zinc from calamine, distinguished between potash and soda by the flame test, and recognised alumina in clay. In 1747 he discovered beet sugar in beetroot, and revealed the possibility of the sugar-beet industry.

MARIGNAC

Marignac, Jean Charles Galissard de
Swiss chemist

b. April 24, 1817, Geneva

d. April 16, 1894, Geneva

Educated in Paris and at the School of Mines, Marignac also studied for a time under Liebig at Giessen. He became professor of chemistry at Geneva (1841) and Zurich (1878), and was famous for his investigation of the rare earths. In 1878 he discovered ytterbium, and in 1880 gadolinium. He made some atomic weight determinations and in 1865 suggested that atoms of different masses may be the cause of deviations from Prout's Hypothesis. This was a forecast of isotopes.

Mariotte, Edme

French physicist

b. 1620, Dijon, Burgundy

d. May 12, 1684, Paris

A prior of St. Martin-sous-Beaune, Mariotte wrote papers on hydrostatics and hydraulics. Boyle's law was for a long time known as Mariotte's law in France because of the Frenchman's independent discovery of it. He was one of the original members of the French Academy of Sciences. His investigation of sap pressure in plants was the earliest experimental work on plant physiology. In 1666 he discovered the blind spots in the eye.

Marius, Simon (Ger. Mayr)

German astronomer

b. 1570, Gunzenhausen

d. Dec. 26, 1624, Ansbach

A pupil of Tycho Brahe, and one of the earliest users of a telescope, Marius gave to the four satellites of Jupiter the names Io, Europa, Ganymede and Callisto, and he claimed to have discovered them in 1609 independently of Galileo. Other astronomers, however, refused to recognise his claims and would not use his suggested names, merely numbering the satellites. He observed sunspots in 1611 and was the first to observe the Andromeda nebula with a telescope (in 1612).

Marsh, James

English chemist

b. Sept. 2, 1794

d. June 21, 1846

An expert on poisons, Marsh worked at the Royal Arsenal at Woolwich, and with Faraday at the Military Academy for a wage of thirty shillings a week. Under the circumstances it is not surprising that he left a wife and family in needy circumstances. He was the inventor of a standard test for arsenic (*Edinburgh Philosophical Journal*, Oct. 1836) which has since carried his name. The arsenic is reduced to arsine by action of zinc and sulphuric acid and is decomposed in a heated glass tube to a product soluble in sodium hypochlorite solution.

Marsh, Othniel Charles

American palaeontologist

b. Oct. 29, 1831, Lockport

d. Mar. 18, 1899, New Haven

Educated at Yale, New Haven and in Germany, Marsh, professor at Yale (1866-99), was known for his expeditions to the Rocky Mountains. There he discovered over a thousand new species of extinct American vertebrates which he described in various monographs. He found the first pterodactyl in America (1871), remains of Cretaceous toothed birds, and of the ancestors of the horse. His remarkable range of finds did much to substantiate the theory of evolution. His collection is housed at Yale.

Maskelyne, Nevil

English astronomer

b. Oct. 6, 1732, London

d. Feb. 9, 1811, Greenwich

Educated at Cambridge, Maskelyne became an F.R.S. in 1758 and Astronomer-Royal in 1765, a post which he held for forty-six years. The founder of the *Nautical Almanac* (1767), he was the first at Greenwich to measure time to tenths of a second. In 1774 he measured the mean density of the earth by an experiment with a pendulum near Schiehallion, a mountain in Perthshire. He devised a lunar method of determining longitude, and invented a prismatic micrometer.

Maupertuis, Pierre Louis Moreau de

French mathematician and astronomer

b. July 17, 1698, St. Malo, Ille-et-Vilaine

d. July 27, 1759, Basle

While he served in the army, mathematics was Maupertuis' leisure study and he later led an expedition to Lapland to measure a degree of the meridian. After his military term, during which time he was once a prisoner of the Austrians, he went to Berlin to become president of the Royal Academy of Sciences. A follower of Newton, he is noted as the discoverer of the principle of least action (1744), though some authorities dispute his claim to this. His work was much interrupted by constant academic quarrels, and he was unlucky enough to be the subject of Voltaire's satire. The results of his Lapland expedition were published in *Sur la figure de la terre* (1738), and demonstrated the flattening of the earth in the polar regions.

Maury, Matthew Fontaine

American hydrographer

b. 1806, Spottsylvania, Virginia

d. Feb. 1, 1873, Lexington, Virginia

A naval officer, Maury became lame through accident and was obliged to retire from the service. As superintendent, Naval Observatory (1842-61), he made a thorough study of the winds and currents of the oceans from log-books of ships (which he had prepared and distributed), and so founded the science of ocean meteorology. His work was of such value that an international committee was formed to develop the matter. He charted the Atlantic sea-bed with a view to the laying of a submarine cable. A supporter of the South in the Civil War, he was obliged to leave America for a time but returned to become professor of meteorology at Virginia Military Institute (1868-73). Maury Hall, U.S. Naval Academy, Annapolis, is named from him, and he was elected to the American Hall of Fame.

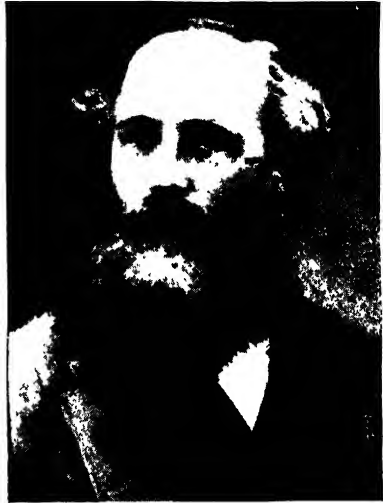
Maxwell, James Clerk

Scottish physicist

b. Nov. 13, 1831, Edinburgh

d. Nov. 5, 1879, Cambridge

Educated at Edinburgh and Cambridge, Maxwell became professor of natural philosophy at Aberdeen in 1856 and at King's College, London, in 1860. In 1871 he was appointed professor of experi-



JAMES CLERK MAXWELL, called 'dattie' at the Edinburgh Academy, had his first paper published by the Royal Society of Edinburgh when he was fifteen.

mental physics at Cambridge where he organised the Cavendish laboratory. He elucidated the mathematical nature of the electro-magnetic field, and completely revolutionised electrical theory by his electromagnetic theory of light (about 1865). This led to the discovery of electric waves and he was able to show that the known velocity of light was identical with the velocity of his waves and that both were transverse. His *Treatise on Electricity and Magnetism* was published in 1873. His theory was largely neglected until in 1888 Hertz produced experimental evidence of electromagnetic waves of much greater length than light waves. Maxwell proved from theoretical considerations that the rings of Saturn could not be solid and continuous (see J. E. Keeler). On his electromagnetic theory he showed that light should exert mechanical pressure, later verified by Crookes, and his earlier investigations included colour vision (in which connection he evolved the Maxwell disc), and colour-blindness, the kinetic theory of gases, and heat, and he wrote

MAYER

a well-known text-book, *Matter and Motion* (1876). See L. Campbell and W. Garrett, *James Clerk Maxwell*.

Mayer, Julius Robert von
German physicist

b. Nov. 25, 1814, Heilbronn, Württemberg
d. Mar. 20, 1878, Heilbronn
After studying medicine at Tübingen, Mayer practised for a time as a doctor. Famous for his discovery of the principle of the conservation of energy (the first law of thermodynamics), he obtained so little recognition and suffered under family disasters to such an extent that he attempted suicide. Still later he was certified insane and though making a partial recovery he never regained normality. Many phenomena were explained by him with varying success in the light of his *a priori* formulation of the first law.

Mayo, Charles Horace
American surgeon

b. July 19, 1865, Rochester, Minn.
d. May 26, 1939
Educated at Northwestern University and Chicago, Charles Mayo practised as a surgeon and with his brother (see below) and father founded the Mayo Clinic. Among a wide range of surgical operations he made a special study of goitre, and his work reduced the death rate for this by 50 per cent. The brothers gave one and a half million dollars for the foundation of the famous clinic at Rochester which is now part of the University of Minnesota.

Mayo, William James
American surgeon

b. June 29, 1861, Le Sueur, Minn.
d. July 28, 1939
Educated at Michigan and Dublin, William Mayo practised surgery in Minnesota and with his brother (see above) founded the clinic named after them. He was a specialist in stomach surgery and the clinic is famous for the number, success and documentation of its operational work.

Mayow, John
English chemist

b. May 24, 1640, London
d. Sept., 1679, London

A fellow of All Souls, Oxford, and of the Royal Society, Mayow practised medicine and following up Boyle's work found that air contained two gases, only one of which, *spiritus m^{pho}-aereus* (oxygen), supports life and combustion and converts venous to arterial blood. He thus preceded Priestley and Lavoisier by a century.

Mead, Warren Judson
American geologist

b. Aug. 5, 1883, Plymouth, Wis.
Educated at Wisconsin, Mead was professor of geology there from 1918 to 1934 and then became head of the department of geology at the Massachusetts Institute of Technology. He collaborated with C. K. Leith in estimating the percentage of shales, sandstones and limestones in sediments.

Méchain, Pierre François André
French astronomer

b. Aug. 16, 1744, Laon
d. Sept. 28, 1804, Spain
A collaborator with Delambre in the measurement of an arc of the meridian, Méchain was also the discoverer of some eleven comets. He was a member of the Academy of Science and of the Institute and died of yellow fever while engaged in extending his meridian Dunkirk-Barcelona to the Balearics.

Mechnikov, Ilya (also Élie Metchnikoff)
Russian biologist

b. May 15, 1845, Ivanovka, Kharkov
d. July 16, 1916, Paris
Educated in Kharkov, Mechnikov became professor of zoology and comparative anatomy at Odessa in 1870 and succeeded Pasteur in Paris in 1895 at the Institute. He was the Nobel prize winner for medicine in 1908 with Ehrlich, for his work on immunology. He did work on cholera and was the discoverer and namer of phagocytes, cells which devour infective organisms. He studied also the causes of death, being of the opinion that life could be prolonged to the age of 150, while senility was to be retarded by taking soured milk on account of the therapeutic value of lactic ferments.

Meitner, Lise

Austrian physicist

b. Nov. 7, 1878, Vienna

A professor of physics and member (1917-38) of the Kaiser Wilhelm Institute at Berlin, Lise Meitner discovered with Hahn in 1917 the new radioactive element protactinium, and in 1935 found evidence of four other radioactive elements corresponding to atomic numbers 93, 94, 95 and 96. She has done much work on nuclear physics in general, including work on the three main disintegration series and on beta-rays. In 1938 she went to Sweden to the Nobel Physical Institute, and in 1947 to the Royal Swedish Academy of Engineering Sciences, Stockholm.

Melloni, Macedonio

Italian physicist

b. Apr. 11, 1798, Parma

d. Aug. 11, 1854, Portici, Campania

Professor of physics at Parma from 1824 to 1831, Melloni had to escape to France on account of his political activities. He returned to Naples in 1839 and was director of the Vesuvius Observatory till 1848. Famous for his work on radiant heat, he devised apparatus for experimental research on the reflection of thermal radiations, and was the inventor of a galvanometer and thermopile arrangement for the measurement of radiant heat. He invented the term *diathermancy* for the capacity of transmitting infra-red radiation, and studied the effect of various substances on transmitted rays.

Melville, Thomas

Scottish scientist

b. 1726

d. Dec. 1753, Geneva

Educated at Glasgow for the Church, Melville was the first (in 1752) to study the spectra of luminous gases. His early death prevented the continuance of his work which was not generally appreciated at the time. He studied also optics and propounded theories of the refrangibility and aberration of light.

Menaechmus

Greek mathematician

b. 375 B.C.

d. 325 B.C.

One of the tutors of Alexander the Great, Menaechmus was the first to investigate conics as sections of a cone, showing how to obtain the ellipse, parabola and hyperbola.

Mendel, Gregor Johann (or Johann Gregor)
Austrian biologist

b. July 27, 1822, Heinzendorf

d. Jan. 6, 1884, Brunn (Brno)

Educated at an Augustinian convent in Brunn, and at Vienna in the physical sciences, he returned to his convent (1853), and in 1868 became abbot. He is famous for his researches on heredity, conducted with peas in his convent garden between 1857 and 1868, but not generally known until publicised by de Vries and others in 1900. In the meantime the application of his theories (since proved correct) to other plants, such as hawk-weeds, revealed difficulties which he could not explain, and on this account he died a perplexed and disappointed man. His theory of dominant and recessive characters (Mendelian law, inheritance) is second only to Darwin's work in biological importance.

Mendel, Lafayette Benedict

American chemist

b. 1872, Delhi, N.Y.

d. 1935

Educated at Yale, Breslau and Freiburg, Mendel rose to be professor of physiological chemistry at Yale. He did much original work on vitamins, digestion, protein metabolism and the physiology of growth. He discovered vitamin A and the function of vitamin C.

Mendelejeff, Dmitri Ivanovitch

Russian chemist

b. Feb. 7, 1834, Tobolsk

d. Feb. 2, 1907, St. Petersburg

The fourteenth child of a Siberian teacher, Mendelejeff had a hard life as a youth. His mother brought him by road to Moscow to enter the university, only to see his admission refused on account of his birthplace. He succeeded however in entering a teachers' training college at St. Petersburg when sixteen, his mother dying the same year. He eventually rose to become pro-



DMITRI IVANOVITCH MENDELEJEFF in his workshop.

fessor at St. Petersburg (1866), having held appointments at Heidelberg and elsewhere, but resigned in 1890 owing to a dispute with the authorities. In 1893 he became director of the Bureau of Weights and Measures. He is famous for his presentation in 1869 of the Periodic Law, the credit for which he shares with Meyer, who probably originated the idea a little earlier but published his results a little later. Mendeleeff's predictions based on his table, and the discovery of gallium and scandium filling in two of the blanks in the periodic list, served to heighten the interest taken in this remarkable arrangement of the elements, and the theory did much to encourage the search for analogous properties of those elements in the same groups. His most famous book was *Principles of Chemistry* (1868, trans. 1905). See also J. A. R. Newlands.

Mercator, Gerardus (Flem. Gerhard Kremer)

Flemish mathematician and geographer
b. Mar. 5, 1512, Rupelmonde, Flanders
d. Dec. 5, 1594, Duisburg

The son of a shoemaker, Mercator studied at Louvain and became a lecturer in geography and astronomy. Later he became professor of cosmography at Duisburg (1552). He is famous for his construction of celestial and terrestrial globes (1551 and 1541), for his maps, and for the invention (1568) of the projection named after him which is very widely used in map-making, but which obtained scant recognition during his lifetime. He was the first to apply the word *atlas* to a collection of maps (from the figure of Atlas bearing the earth commonly placed on the front). At one time he was prosecuted for heresy. His maps include his

earliest (1537), one of the Holy Land, of Flanders (1537-40), the world (1538), his globes (above), Europe (six sheets; 1554), and his atlas, begun in 1545 and finished by his son.

Mercator, Nicolaus (Ger. Kaufmann)
German mathematician and astronomer
b. c. 1620
d. 1687

While practising as an engineer, Mercator was responsible for the erection of the fountains at Versailles; and in the realm of mathematics, a series for $\log(1+x)$ is attributed to him. He resided in England from 1660 onwards.

Mercer, John
English chemist
b. Feb. 21, 1791, Dean, nr. Blackburn
d. Nov. 30, 1866

Engaged in the cotton trade, in 1850 Mercer invented the process of treating cotton with caustic soda thus producing what has since been known as mercerised cotton. He was also the discoverer of certain calico dyes.

Mergenthaler, Ottmar
German-American inventor
b. May 11, 1854, Hachtel, Germany
d. Oct. 28, 1899, Baltimore
Going to the United States in 1872, Mergenthaler became an American citizen in 1878, and is remembered as the inventor of the Linotype machine, the original form appearing in 1884. This has been of great importance in the development of modern high-speed printing.

Mersenne, Marin
French natural philosopher
b. Sept. 8, 1588, La Soultière, Sarthe
d. Sept. 1, 1648, Paris
A Franciscan friar who was one of the first to investigate sound, Mersenne discovered the laws of vibrating strings independently of Galileo. He was the first to measure the velocity of sound experimentally, his result from timing echoes being 1,038 feet per second. He was also the first to determine the frequency of a musical note, and to show that raising a note an octave doubles

its frequency. He was a fellow pupil and supporter of Descartes. He wrote on the application of his theories to music, and on physics, astronomy and mathematics.

Mesmer, Friedrich Anton
Austrian physician
b. May 23, 1733, Weil, nr. Constance
d. Mar. 5, 1815, Meersburg
While studying medicine at Vienna, Mesmer became inclined to mysticism and studied astrology. As a result of experiments on the curative powers of magnets he 'discovered' that he possessed a kind of occult force, and evolving his theory of animal magnetism he held séances in Vienna until the police forced him to leave. In Paris he claimed to cure disease, but was regarded as a fraud by contemporary medical authorities. He undoubtedly was an exponent of hypnotism (mesmerism) and was the subject of an official scientific inquiry instigated by the French government. He was denounced by this as a fraud, not so much because scientists disbelieved his results but because they disagreed with the interpretation which he placed upon them.

Meusnier, Jean Baptiste Marie
French soldier and scientist
b. June 19, 1754, Paris
d. June 13, 1793, Mayence
Apart from his military exploits as a general and his aeronautical ascents in a balloon, Meusnier is known as the discoverer of a theorem which carries his name (1777). This relates to the centre of curvature of any plane section.

Meyer, Julius Lothar
German chemist
b. Aug. 19, 1830, Varel, Oldenburg
d. Apr. 12, 1895, Tübingen
Trained in medicine and chemistry at Zürich, Würzburg and Heidelberg, Meyer became professor of chemistry at Karlsruhe, and at Tübingen in 1876. He discovered the Periodic Law independently of Mendelejeff at almost the same time (1869), but did not work it out quite so thoroughly. In 1870 he showed the dependence of atomic volume on atomic weight

MEYER

by the production of a curve relating the two, and showing the periodicity of the elements. He studied also the chemistry of the blood.

Meyer, Viktor

German chemist

b. Sept. 8, 1848, Berlin

d. Aug. 8, 1897, Heidelberg

One of the leading organic chemists of the last century, Meyer studied under Bunsen in Heidelberg and finally worked under Baeyer. He became professor at the Zürich Polytechnic in 1872, then at Göttingen, and in 1889 at Heidelberg. He discovered thiophene and the oximes and investigated them. His constitution was undermined by work at high temperatures on bromine and iodine using a modification of his well-known vapour density method, and his suicide was occasioned by ill-health.

Meyerhof, Otto Fritz

German physiologist

b. Apr. 10, 1884, Hanover

d. Oct. 6, 1951, Philadelphia

Educated at Berlin, Freiburg, Strasbourg



ALBERT A. ABRAHAM MICHELSON demonstrated that the apparent speed of light remains unaffected by relative motion towards or from the light source, and opened the way for Einstein's theories.

and Heidelberg, Meyerhof became professor at Kiel (1918-24), going from there to the Kaiser Wilhelm Institute for Biology to become director of the department of physiology (1924-29), and then (1930-38) to a similar chair at Heidelberg. Noted for his work on the metabolism of muscles, he showed that lactic acid is formed there by the breakdown of glycogen. During rest some of this lactic acid combines with oxygen to reconvert the remainder into glycogen. He shared with A. V. Hill the 1922 Nobel prize for medicine for this work. His publications include *Ueber die chemische Vorgänge im Muskel* (1930).

Michell, (Rev.) John

English geologist

b. 1724, Nottinghamshire

d. Apr. 29, 1793, Thornhill, Yorks.

Educated at Cambridge, Michell became a Fellow of Queen's College, and professor of geology (1769). He was elected F.R.S. in 1760 and in 1767 became Rector of Thornhill. He designed the apparatus which Cavendish used to determine the constant of gravitation. Michell died before he was able to make any measurements and the apparatus was given to Cavendish. His outline of the method to be used described for the first time the torsion balance, invented later independently by Coulomb. He devised a method of magnetisation (*A Treatise of Artificial Magnets*, 1750), founded seismology (*Conjectures ... upon the Phenomena of Earthquakes*, 1760), and wrote on astronomy.

Michelson, Albert Abraham

American physicist

b. Dec. 19, 1852, Strelno, Germany

d. May 9, 1931, Pasadena

Educated at the U.S. Naval Academy, Berlin, Heidelberg and Paris, Michelson became professor of physics at Chicago in 1892 after holding a similar post at Clark University (1889-92), and was awarded the Nobel prize for physics in 1907. He conducted notable experiments on the velocity of light, obtaining a result of $299,860,000 \pm 30,000$ metres per second, and with Morley he performed a famous experiment to determine ether drift, the negative result

of which led to the theory of relativity. He invented an interferometer which resolved into components many spectral lines previously thought to be homogeneous, both the sodium lines, for example, being doubled. The inventor of an echelon grating which is much easier to make than a line grating and gives enormous resolving power, he measured the wavelength of the red cadmium line to an accuracy of one in a million, and with it measured a metre for the Bureau International des Poids et Mesures, Paris. He showed that spectrum lines broaden at 300°C ., and also succeeded in measuring tides in a closed pipe 500 feet long.

Midgley, Thomas, Jr.

American chemist

b. May 18, 1889, Beaver Falls, Pa.

An experimenter in the field of internal combustion, he is responsible for the introduction of lead tetraethyl as an anti-knock agent. He also investigated the use of organic chlorofluorides as safe refrigerating compounds.

Millikan, Robert Andrews

American physicist

b. Mar. 22, 1868, Morrison, Illinois

d. Dec. 19, 1953

Educated at Oberlin College, where he became physics instructor, Millikan went to Columbia, Berlin and Göttingen, and eventually became professor of physics at Chicago in 1910 and in 1921 at the Californian Institute of Technology. He was awarded the Nobel prize for physics in 1923 for his measurements of the electron. He conducted experiments in electricity from which it has been possible to determine the number of molecules in unit volume of a gas at a given pressure, and also made a determination of the value of 'e' for an electron, obtaining a result of 4.802×10^{-10} absolute electrostatic units. His 'oil drop' experiments in connection with this fundamental electric quantity are famous, and he has done notable work on X-rays, cosmic rays, the photoelectric calculation of Planck's constant, and the ultra-violet spectrum. He is the author of many scientific works, including *The Electron* (1917) and *Cosmic Rays* (1939).



ROBERT A. ANDREWS MILLIKAN measured the negative charge on the electron, and found that an electric charge is not continuous but varies only by integer products of the electronic charge.

Milne, Edward Arthur

English astrophysicist

b. Feb. 14, 1896, Hull

d. Sept. 21, 1950, Dublin

Educated at Cambridge, Milne was assistant director of the Solar Physics Observatory there from 1920 to 1924. After holding many academic appointments he became professor of mathematics at Oxford in 1928, and was president of the Royal Astronomical Society from 1943 to 1945. He made notable contributions to the study of cosmic dynamics and came to the conclusion that the age of the universe is about two thousand million years. He is the author of several books on astronomy and relativity.

Milne-Edwards, Henri

French zoologist

b. Oct. 23, 1800, Bruges

d. July 29, 1885, Paris

Of English parentage (father), Milne-Edwards was educated at Paris in medicine but turned to the study of the zoology of the lower animals. He became professor

MINKOWSKI

of entomology at the Muséum d'Histoire Naturelle and later professor of zoology. He published, among other works, *Histoire Naturelle de Crustacés* (1837) and a parallel book on corals. He stressed the physiological specialisation of functions in organisms.

Minkowski, Hermann

Russian-German mathematician

b. June 22, 1864, Alexota by Kovno

d. Jan. 12, 1909, Göttingen

Minkowsky held successive professorships at Königsberg (1895), Zürich (1896), Göttingen (1902). He is remembered for his important work on the mathematical basis of relativity, especially the elegant four-dimensional mathematical form in which he clothed Einstein's Special Relativity Theory (*Raum und Zeit*, 1907). *Zwei Abhandlungen über die Grundgleichungen der Electrodynamik* appeared in 1909. He devised also a geometrical technique in the study of number-theory.

Minot, George Richards

American physician

b. Dec. 2, 1885, Boston, Mass.

d. Feb. 25, 1950

Educated at Harvard, Minot occupied many high academic posts in hospitals before becoming professor of medicine at Harvard (1928-48). He was the first to suggest, with Murphy, the value of liver diet for pernicious anaemia, and their work in this field gained them, with G. H. Whipple, the Nobel prize for medicine in 1934.

Mitscherlich, Eilhardt

German chemist

b. Jan. 7, 1794, Neuende, Oldenburg

d. Aug. 28, 1863, Schönberg, nr. Berlin

Beginning as a student of Oriental languages, Mitscherlich turned to medicine and finally to chemistry, which he studied under Berzelius. He became professor in Berlin in place of Klaproth, and was famous for his researches on crystalline structure. He performed experiments on the variation in the inclination of the optic axes in biaxial crystals with a temperature

change. In 1819 he discovered isomorphism, that is the replacement of one element by another in a compound, without alteration of the crystalline form. He was one of the earliest chemists to recognise catalysis, which he called 'contact action', and did notable work on benzene and its derivatives. He experimented also on artificial minerals.

Mohl, Hugo von

German botanist

b. Apr. 8, 1805, Stuttgart

d. Apr. 1, 1872, Tübingen

Educated at Tübingen and Munich, Mohl became professor of botany at the former university. He conducted important researches on the anatomy and physiology of vegetable cells, and discovered and named protoplasm (1846).

Mohs, Friedrich

German mineralogist

b. 1773, Gernrode, Harz Mts.

d. Sept. 29, 1839, Agordo, nr. Belluno, Italy
Professor at Graz and Freiburg, and later at Vienna, Mohs wrote a famous *Treatise on Mineralogy* (1825). He also devised in 1820 the scale of hardness which carries his name. This consists of a series of ten selected minerals ranging from talc to diamond, in gradually increasing hardness; the tests are made by comparative scratching.

Moissan, Ferdinand Frédéric Henri

French chemist

b. Sept. 28, 1852, Paris

d. Feb. 20, 1907, Paris

Beginning as an apothecary's assistant, Moissan then studied chemistry and pharmacy under Frémy, becoming eventually professor of chemistry in Paris (1900). In 1886 he was the first to isolate fluorine, in the quest for which Jérôme Nickles and Paulin Louyet had given their lives, and which affected his own health. He invented also the electric furnace in 1892 and with it prepared metal carbides, silicon carbide and artificial diamonds. He was awarded the Nobel prize for chemistry in 1906.

Mond, Ludwig

German-British chemist

b. Mar. 7, 1839, Cassel, Germany

d. Dec. 11, 1909, London

After study at Marburg and Heidelberg under Kolbe and Bunsen respectively, Mond set up in England as chemical manufacturer and became a British subject in 1867. With Brunner he built up the great firm carrying their names, which later became the Imperial Chemical Industries. Mond invented many new processes in the alkali industry, for example in connection with the recovery of ammonia in the Solvay process, and he discovered a new type of producer gas, named after him. His work on nickel, in the course of which nickel carbonyl was discovered, was of the highest importance in the development of the industry, especially in Canada. In 1896 he founded the Davy-Faraday laboratory at the Royal Institution. His elder son, Sir Robert Ludwig Mond (1867-1938), chemist and archaeologist, continued his father's industrial and philanthropic activities.

Monge, Gaspard, Comte de Péluse

French mathematician

b. May 10, 1746, Beaune, Côte d'Or

d. July 28, 1818, Paris

Educated in his native city and at Lyons, Monge went from the chair of physics at Mézières to the Lyceum in Paris as professor of hydraulics (1780). Honoured during the time of Napoleon's greatness, he suffered at the Emperor's fall from power, incurring the disfavour of the new government. He is celebrated as the inventor of descriptive geometry and in particular for his discovery of the curves of curvature of a surface. In 1783 he exploded oxygen and hydrogen in a glass globe electrically to obtain water, but his results were not so accurate as those of Cavendish, though entirely independent. He was instrumental in the founding of L'École Polytechnique (1794).

Moniz, Antonio Egas

Portuguese neuro-surgeon

b. 1874

A professor emeritus of Lisbon University, Moniz has enjoyed equal distinction as

diplomat and neurologist. He was Foreign Minister of Portugal in 1917, leader of the Portuguese delegation to the Versailles Peace Conference and Minister to Spain. He has made two major contributions to medical practice: the development of cerebral angiography (injection of radio-opaque matter into the internal carotid artery) as a method of diagnosis of intracranial disease (1927-37); and the introduction of prefrontal leucotomy (or lobotomy) for the relief of severe schizophrenia and paranoia (1935-36). The operation consists of surgical scission of the association fibres connecting the frontal lobes of the brain and the thalamus. For this work he shared with W. R. Hess the Nobel prize for medicine in 1949.

Montgolfier, Joseph Michael

French inventor

b. 1740, Vidalon-lès-Annonay, Ardèche

d. 1810

The brother of Jacques (see below), he was, with him, the first successful balloonist. He also invented the water-ram.

Montgolfier, Jacques Étienne

French inventor

b. 1745, Vidalon-lès-Annonay, Ardèche

d. 1799

The brother of Joseph, he shares with him the credit for the invention of a workable balloon, inflated with heated air. The first ascent, which lasted for ten minutes, was made from their home town in 1783.

Morgagni, Giovanni Battista

Italian anatomist

b. Feb. 25, 1682, Forlì

d. Dec. 6, 1771, Padua

Educated at Bologna, Morgagni became professor of anatomy at Padua when twenty-nine and stayed there 56 years. The founder of pathological anatomy, he made many notable discoveries on the causes of disease, being for example, the first to describe cirrhosis of the liver. His anatomical descriptions include studies of the larynx and female pelvis, and his teaching was of first importance in the development of his subject. His monumental *De sedibus et causis morborum* (5 vols.) was published in 1761.

MORGAN

Morgan, Augustus de. See **De Morgan**

Morgan, Thomas Hunt

American biologist

b. Sept. 25, 1866, Lexington, Ky.

d. Dec. 4, 1945, Pasadena

Educated at Kentucky and the Johns Hopkins University, Morgan became professor of biology at Bryn Mawr College, and later at Columbia. In 1928 he went to the Californian Institute of Technology in the same capacity. An expert on problems of heredity, he published many works on the subject including *The Theory of the Gene* (1926), *Experimental Embryology* (1927) and *Embryology and Genetics* (1933). He was awarded the Nobel prize for medicine in 1933 for his discoveries relating to the hereditary functions of the chromosomes.

Morley, Edward Williams

American chemist

b. 1838, Newark, N. Jersey

d. 1923

After studying theology at Williams College Mass., Morley abandoned the Church for chemistry, becoming professor of chemistry at Western Reserve University and later at Cleveland Medical College, Ohio. He was associated with Michelson in the famous experiment on ether drift and the velocity of light, the negative result of which led to the theory of relativity. He also made an exceedingly accurate determination of the ratio of the combining weights of oxygen and hydrogen.

Morse, Harmon Northrup

American chemist

b. 1848

d. 1920

Educated at Amherst and Göttingen, Morse rose to be professor of chemistry at the Johns Hopkins University and director of the chemical laboratories. He made many accurate determinations of atomic weight, e.g. cadmium and zinc, and also did important work on osmotic pressure.

Morse, Samuel Finley Breese

American inventor

b. Apr. 27, 1791, Charlestown, Mass.

d. Apr. 2, 1872, New York

Educated at Yale, Morse spent the first part of his life studying art and did not turn to science until 1832. He then spent twelve years on the invention and perfecting of his magnetic telegraph instrument. He also invented the well-known code to be used with it. Morse had the greatest difficulty in obtaining recognition of his patent rights and endeavoured to establish patents in various countries for many years before being successful.

Mosander, Carl Gustav

Swedish chemist

b. 1797, Kalmar

d. 1858, Angsholm

Trained in medicine and pharmacy, Mosander served for a time as an army surgeon and eventually became professor of chemistry and mineralogy at Stockholm. He was an assistant to and friend of Berzelius, and in his investigation of the rare earths he was the discoverer of the rare element didymium in 1842 and of erbium in 1843. Didymium was later found to be a compound of praseodymium and neodymium. He also discovered lanthanum and terbium in 1839 and 1843.

Moseley, Henry Gwyn-Jeffreys

English physicist

b. Nov. 23, 1887, Weymouth

d. Aug. 10, 1915, Gallipoli

Educated at Eton and Oxford, Moseley went to Manchester as lecturer and demonstrator in physics and, after two years, resigned to devote himself to research. A physicist of brilliant promise, he made the important discovery of the relationship between X-ray spectra and atomic number. His death in action as a young man, while his recall from the trenches was actually on its way, robbed science of what might have been one of its brightest ornaments.

Moulton, Forest Ray

American astronomer

b. Apr. 29, 1872, Le Roy, Mich.

Educated at Albion College, Michigan, Chicago and Drake Universities and the Case School of Applied Science, Moulton has occupied astronomical posts at Chicago since 1898, being professor from 1912 to

1926. The writer of many astronomical works and also books on ballistics and differential equations, he was associated with Chamberlin in his work on the planetesimal or spiral-nebula hypothesis of the origin of the solar system.

Mulder, Gerard Johann
Dutch chemist
b. 1802
d. 1880

Professor of chemistry at Utrecht, Mulder obtained a complex substance which he named *proteine*, but later found it to be a mixture of nitrogenous products. To these the name *proteins* was given. In addition he isolated fibrin, the proteid appearing in clotting blood.

Müller, Franz Joseph, Baron von Reichenstein
Austrian chemist and mineralogist
b. 1740, Nagyszeben (Sibiu, Rum.)
d. 1825, Vienna
Educated at Vienna in law and philosophy, Müller abandoned those studies for mining. In 1783 he discovered a new metal, specimens of which he sent to Bergman, and later to Klaproth who named it *tellurium*.

Müller, Fritz
German naturalist
b. 1821
d. 1897

A pupil of Johannes Müller (see below), Fritz Müller, while a merchant in Brazil, studied the development of Crustacea. He developed the idea of ancestral recapitulation as evidence in favour of the theories of Darwin (*Für Darwin*, 1864). He also made observations on mimicry which extended the ideas of Bateson, and with his brother Hermann did considerable work on pollination.

Muller, Hermann Joseph
American biologist
b. Dec. 21, 1890, New York
Educated at Columbia University, Muller held posts in Moscow and Edinburgh as well as in his own country, and went to Amherst College in 1940. For twenty years, with other American biologists, he has been

studying *Drosophila* in order to formulate a theory of genes, probably the greatest advance in biology since Darwin. In particular he has made some remarkable experiments on the influencing of genes by physical processes, and exposing them to X-rays has produced 'artificial' mutations in large numbers. He found that no other physical changes, eg., heat, light, cold, motion, etc., seem to have any effect on the genes. He was awarded the Nobel prize for physiology in 1946.

Müller, Johann, see Regiomontanus

Müller, Johannes Peter
German physiologist and anatomist
b. July 14, 1801, Coblenz
d. Apr. 28, 1858

The son of a shoemaker, Müller studied medicine at Bonn, and after being professor of anatomy and physiology at Bonn, went to Berlin in 1833. He was one of the greatest biologists of all time and especially famous for his discovery of the principle of specific nerve energies. This states that the sensation following upon nerve stimulation depends on the organ to which the stimulated nerve is connected, not on the form of stimulation. For example, any stimulus to the optic nerve results in a sensation of light. He discovered the Müllerian duct in females and did work also on hermaphroditism, embryology, echinoderms, fishes, lymph, chyle, the blood and the voice, as well as on general pathology. His *Handbuch der Physiologie der Menschen* was published 1833-40.

Müller, Otto Frederick
Danish biologist
b. Mar. 11, 1730, Copenhagen
d. Dec. 26, 1784

In 1773 Müller was the first to describe diatoms. He invented the naturalist's dredge and revealed to the world the new animal kingdom of *Infusoria*.

Müller, Paul
Swiss chemist
b. 1900
In 1939, while working on mothproofing substances for fabrics at the Basle dye-

MURCHISON

stuff research laboratory of J. A. Geigy, S.A., Müller synthesised D.D.T. (known since 1874) and discovered its contact insecticidal properties. The compound proved of immense value during the Second World War in combating malaria and typhus, and led to intensified research on chemical insecticides. For his discovery Müller gained the Nobel prize for medicine for 1948. He subsequently joined the staff of Basle university.

Murchison, Sir Roderick Impey

Scottish geologist

b. Feb. 19, 1792, Tarradale, Ross-shire

d. Oct. 22, 1871, London

Educated at Durham and Great Marlow Military College, Murchison joined the army and served in the Peninsular War in 1807. He was twice president of the Geological Society, a founder of the British Association and director of the Royal School of Mines (1855). In 1841 he introduced the name Permian for a system of rocks, and did much work on the order of formations in Great Britain. With Sedgwick he differentiated the Silurian and Devonian systems, which they so named. Murchison took part (1840-45) in a geological survey of Russia. In 1844 he predicted the discovery of gold in Australia.

Murphy, William Parry

American physician

b. Feb. 6, 1892, Stoughton, Wis.

Educated at Oregon and Harvard, Murphy taught at Harvard for many years before establishing himself in private practice in Boston (1923). Associated with Minot and Whipple in work on anaemia, he was first

(with Minot) to suggest liver diet, and the three were awarded the Nobel prize for medicine in 1934.

Murray, Sir John

British biologist and geographer

b. Mar. 3, 1841, Coburg, Ontario

d. Mar. 16, 1914, Kirkliston, West Lothian

One of the naturalists on the famous *Challenger* expedition and the editor of the reports on it, Murray did research on oceanography and marine biology. He is famous for his explorations of seas, oceans, and the fresh-water lochs of Scotland. He was killed in an accident.

Muspratt, James

British chemist

b. Aug. 12, 1793, Dublin

d. May 4, 1886, Seaforth Hall, nr. Liverpool

After taking part in the Peninsular War, Muspratt returned to his trade of druggist and began manufacturing acids, etc., in Dublin and later in Liverpool. He did much to improve methods of chemical manufacture and was the founder, with Josias Gamble, of the alkali industry in St. Helens, where he produced sulphuric acid and sodium carbonate.

Musschenbroek, Pieter van

Dutch physicist

b. 1692, Leyden

d. 1761, Leyden

After studying at Leyden, and being professor at Duisburg and at Utrecht, Musschenbroek filled the chair of physics at his former university. He invented the pyrometer but is better known for his invention in 1746 of the Leyden jar.

N

Nägeli, Karl Wilhelm von
Swiss botanist and physicist

b. Mar. 27, 1817, Kilchberg, nr. Zürich

d. May 10, 1891, Munich

Professor successively at Zürich, Freiberg, Zürich and Munich, and one of the early writers on evolution, Nägeli considered that environment was not a cause of variation and that evolution may take place in jumps. He made important observations on cell growth and demonstrated by chemical analysis the presence of nitrogenous matter in protoplasm. He postulated the hypothetical micella as a foundation of the structure of starch-grains, cell-walls, etc., and discovered the antheridia and spermatozoids of ferns.

Napier, John, Laird of Merchiston

Scottish mathematician

b. 1550, Merchiston Castle, Edinburgh

d. Apr. 4, 1617, Merchiston

Educated at St. Andrews, Napier pursued mathematics as a hobby rather than a profession. He is remembered for his great creation of logarithms, and incidentally for his introduction of the decimal notation (see Stevinus). The natural base e was found to be rather unsuitable for everyday calculations, and Briggs, after consulting Napier, produced new tables using the base 10. Napier himself had contemplated the change, but did not live to see the heavy calculations completed. His *Mirifici Logarithmorum Canonis Descriptio* (1614) contained his invention of logarithms and the *Rabdologia* (1617) describes methods of mechanical calculation (Napier's bones). Napier was a strict Presbyterian, yet a believer in astrology and divination.

Nasmyth, James

Scottish engineer

b. Aug. 19, 1808, Edinburgh

d. May 7, 1890, London

The son of Alexander Nasmyth the Scottish

artist, James was educated at Edinburgh and in engineering at London, and became the head of a foundry at Patricroft, Manchester, where he made a considerable fortune. He is noted as the inventor of the famous steam-hammer, the idea for which occurred to him in 1839. Watt, however, had thought of it before. He also devised many other steam-driven tools including a planing machine and a hydraulic punching machine. On his retirement to Kent he studied astronomy as a hobby, and with Carpenter produced a well-known work on the moon.

Neckam, Alexander (called Nequam)

English scholar

b. Sept., 1157, St. Albans

d. 1217, Kempsey, Worcestershire

Born on the same night as Richard I, Neckham was nursed by his mother along with the future king. Educated in his native town and later in Paris, he became lecturer in the latter university, but later returned to England as a schoolmaster at Dunstable. He eventually became Abbot of Cirencester (1213). His claim to scientific note lies in the fact that he was the first in Europe to describe the use of a magnet as a compass at sea (about 1180) in his *De naturis rerum* and *De utensilibus*.

Nernst, Walther Hermann

German physical chemist

b. June 25, 1864, Briesen, W. Prussia

d. Nov. 18, 1941, Berlin

Educated at Zürich, Berlin, Graz and Würzburg, Nernst became assistant to Ostwald at Leipzig (1887) and professor of chemistry in Göttingen (1891) and Berlin (1905). In 1933 he was appointed director of the Physical Institute there. In 1889 he introduced his electrolytic solution pressure theory for cells, and in 1906 proposed the heat theorem (third law of thermodynamics). He investigated the specific heat of solids at low temperatures in con-

NEWCOMB

nection with the quantum theory, proposed the atom chain-reaction theory in photochemistry and elaborated the idea of solubility product. An invention of his of a new type of electric lamp has survived only for special laboratory use. He gained the Nobel prize for chemistry in 1920, and is regarded as the founder of modern physical chemistry.

Newcomb, Simon
American astronomer

b. Mar. 12, 1835, Wallace, Nova Scotia
d. July 11, 1909, Washington
Settling in the U.S.A. in 1853 after running away from home, Newcomb was educated at Harvard. After work at the Washington Observatory he became director of the American Nautical Almanac and in 1884 was professor of mathematics and astronomy at the Johns Hopkins University. With Michelson he performed experiments to determine the velocity of light, and he also carried out an immense amount of observational astronomy on the solar system. He was awarded the Copley medal in 1890.



ISAAC NEWTON, from the portrait by Kneller.

Newcomen, Thomas
English engineer

b. Feb. 1663, Dartmouth, Devon
d. Aug. 5, 1729, London

An ironmonger in his native town, Newcomen, working independently of Savery, produced a pumping engine which is regarded as the first successful steam-engine. It was constructed in 1705, and was soon in general use in mines.

Newlands, John Alexander Reina
English chemist

b. 1838, Southwark
d. 1898

After studying under Hofmann, Newlands became a chemist in a sugar refinery at the Victoria Docks. He was the first (1864) to arrange the elements in order of atomic number and to notice the connection between every eighth. This he called the law of octaves, and though ridiculed at the time (one sceptical professor of chemistry asking if he had not tried alphabetical order), it was the first idea of a periodic law. In 1887 he was awarded the Davy medal of the Royal Society, a somewhat tardy recognition of his great discovery.

Newton, Sir Isaac
English mathematician

b. Dec. 25, 1642, (o.s.) Woolsthorpe, Lincs.
d. Mar. 20, 1727, Kensington
Educated at Trinity College, Cambridge, Newton became a fellow of his college in 1667. In 1665 while staying in his native village he is supposed (according to Voltaire who heard it from Newton's step-niece) to have observed an apple fall from a tree and so his mind was turned to the question of gravitation. By 1684 he had completed the greater part of his dynamical theory of gravitation in its applications to the solar system, in which connexion Kepler's third law led him to the conclusion that the attraction between earth and moon is inversely proportional to the square of the distance. He was the first to realise the elliptical path of comets, and was the discoverer of the three basic laws of motion which are the foundation of

practical or Newtonian mechanics. From 1669 he was professor of mathematics at Cambridge, in 1671 he became an F.R.S. and in 1689 a Member of Parliament, eventually becoming Master of the Mint in 1699. In 1703 he became president of the Royal Society, an honour which he held until his death. Among Newton's many discoveries was the connexion between colour and dispersion of light, but he was mistaken in thinking that the dispersion was proportional to the refraction. His *New Theory of Light and Colour* was read to the Royal Society in 1672. He developed the reflecting telescope, and was familiar with the solar spectrum, yet failed to observe the Fraunhofer lines. He observed the coloured interference fringes caused by reflection and refraction through thin films, named Newton's rings, but he realised the difficulty of the wave theory of light because he could find no evidence of light bending round corners as, for example, did sound waves. He therefore advocated a theory in the main corpuscular, and was a believer in the corpuscular theory of matter. In mathematics he introduced the binomial theorem, and after some controversy with Leibniz is accorded the credit for the introduction of the infinitesimal calculus, though the latter's share in the work has been generally underestimated. His great work on dynamics and astronomy is the *Philosophiæ Naturalis Principia Mathematica*, usually known as the *Principia*, written 1685-86, and published by Halley in 1687. His work on optical theory is contained in his *Optics* (1704). His personal character seems to have been not altogether likeable, becoming increasingly quarrelsome and suspicious with the years, witness his disagreements with Flamsteed over the latter's *Greenwich Observations* which Newton used, and his secret dealings in the Leibniz controversy.

Nicholson, Seth Barnes

American astronomer

b. Nov. 12, 1891, Springfield, Ill.

Educated at Drake University, Des Moines, and the University of California, Nicholson held appointments at these until becoming astronomer at the Mt. Wilson Observatory.

He is noted as the discoverer of the 9th, 10th, 11th and 12th satellites of Jupiter, and specialised in solar astronomy. He also worked with Pettit on the surface temperatures of planets, using a thermocouple of their own construction.

Nicholson, William

English physicist

b. 1753, London

d. May 21, 1815, Bloomsbury, London

After a varied career Nicholson eventually turned to science and invention. With Carlisle he constructed the first voltaic pile in England, and so discovered by accident that water could be dissociated by electricity, as they had put a few drops of water on the top plate. He also invented a well-known hydrometer, named after him.

Nicol, William

Scottish physicist

b. 1768

d. 1851, Edinburgh

Earning sufficient money to live by lecturing on natural philosophy, Nicol devoted himself to science. He greatly improved the technique of cutting thin sections of wood for microscopical examination, and is particularly remembered as the inventor (1828) of a special prism (Nicol prism) of Iceland spar, used for investigating the polarisation of light.

Nicolle, Charles Jules Henri

French physician and bacteriologist

b. Sept. 21, 1866, Rouen

d. Feb. 28, 1936, Paris

Educated at Rouen, and a pupil of Pasteur, Nicolle became the Director of the Pasteur Institute at Tunis in 1903. He discovered that the body louse transmits typhus fever. In 1928 he was awarded the Nobel prize for medicine for his work on typhus exanthematicus. In 1932 he became a professor at the Collège de France.

Nieuwland, Julius Arthur

American chemist

b. 1878, Hansbeke, Belgium

d. 1936

An immigrant to the U.S.A. at the age of three, Nieuwland trained at Indiana, took

NILSON

orders as a priest in 1903, and taught at Notre Dame University from 1904, becoming professor of chemistry there in 1923. His researches on acetylene led to the production of artificial rubber (duprene), and he played a prominent part in the discovery of lewisite.

Nilson, Lars Fredrik
Swedish chemist
b. 1840, East Gothland
d. 1899

Educated at Uppsala, in 1878 Nilson became professor of analytical chemistry there and later went to Stockholm as an agricultural chemist. His work on fertilisers turned the sterility of his native island into fecundity. In 1879 he discovered the element scandium and investigated its properties.

Nitze, Max
German surgeon
b. 1848
d. 1906

A pioneer in urology, Nitze was the inventor of the cystoscope in 1877. This, with his subsequent operating cystoscope, provided the basis of modern surgery of the genito-urinary tract.

Nobel, Alfred
Swedish chemist and engineer
b. Oct. 21, 1833, Stockholm
d. Dec. 10, 1896, San Remo
The inventor of dynamite and other things connected with explosives, Nobel is best remembered on account of his having left the greater part of his fortune of £2,000,000 for the annual award of five prizes. These are given for the most important discoveries in physics, chemistry, medicine, literary work and the cause of peace, and were first awarded in 1901.

Nobili, Leopoldo
Italian physicist
b. 1784
d. 1835
Professor of physics at Florence, Nobili was the inventor of the thermopile, an instrument consisting of a number of thermocouples joined in series and used in con-

junction with a galvanometer to measure radiant heat. He also invented the astatic galvanometer, which remains unaffected by the earth's magnetic field.

Nocard, Edmond Isidore Étienne
French biologist
b. 1850
d. 1903

Devoting himself to veterinary science, Nocard made many important discoveries in this field. He discovered the bacillus of bovine glanders, and in research on tuberculosis showed that the bacillus of the avian variety is the same as that of the mammalian. He was also able to show that meat and milk from tubercular cattle could be the cause of infection in man. With Pierre Roux in 1898, he conducted researches on bovine pneumonia which led to the discovery of pneumococcus.

Noddack, Ida Eva
German chemist
b. 1896, Lackhausen bei Wesel
Educated at Berlin, she worked in Siemen's laboratory. In 1925 with her husband (see below) she discovered the elements *rhenium* and *masurium*. El. 43 is now known to be *technetium*.

Noddack, Walter Karl Friedrich
German chemist
b. 1893, Berlin
Educated at Berlin, he became professor of physical chemistry at Freiburg in 1935. With his wife he discovered the elements *masurium* and *rhenium* (see above).

Noguchi, Hideyo
Japanese bacteriologist
b. Nov. 24, 1876, Inawashiro, Fukushima
d. May 21, 1928, British West Africa
Educated at Tokio and in Europe, Noguchi entered the Rockefeller Institute for Medical Research in 1904, after publishing a paper on snake venom. He was the first to secure pure cultures of syphilis spirochaete and devised new tests for the disease and its infections. He also discovered the parasite of yellow fever (1918) and prepared a vaccine and serum to be used for this disease. He himself succumbed to yellow fever in British West Africa.

Nollet, Jean Antoine, Abbé
French physicist
b. Nov. 19, 1700, Pimpré, Noyon
d. Apr. 12, 1770, Paris

Of peasant stock, Nollet became professor of physics in Paris (1738), an F.R.S. (1734), and was a friend of Duhamel and Mus-schenbroek. He was the discoverer of osmosis in 1748, when he noted that water passed through a piece of pig's bladder into a bottle full of spirits of wine. An electro-scope and improved Leyden jar were among his inventions.

Northrop, John Howard
American biochemist
b. July 5, 1891, Yonkers, N.Y.

337

NORTHROP

Educated at Columbia and Harvard, Northrop rose from an assistantship at the Rockefeller Institute for Medical Research to membership in 1924. In 1942 he became consultant and official investigator to the National Defence Research Committee. He discovered the fermentation process for the manufacture of acetone and has done much work on enzymes and the kinetics of enzyme reactions, publishing *Crystalline Enzymes* (1939). In 1946 he was awarded the Nobel prize for chemistry with W. Stanley, for their study of methods of producing purified enzymes and virus products. In 1930 he isolated the gastric proteolytic enzyme as hexagonal crystals, and in 1932 trypsin, and other pancreatic enzymes.

338

O

Obel, Matthias ~~de l'~~. See **L'Obel**

Odling, William

English chemist

b. 1829, London

d. Feb. 17, 1921

Training in medicine, Odling turned to chemistry and eventually became professor of chemistry at Oxford, after holding a similar appointment at the Royal Institution. He became a Fellow of the Royal Society in 1859. He classified the silicates and put forward suggestions with respect to atomic weights which made $O=16$ instead of 8. His formula for ozone was O_3 .

Oersted, Hans Christian

Danish physicist and chemist

b. Aug. 14, 1777, Rudkjøbing

d. Mar. 9, 1851, Copenhagen

After studying medicine at Copenhagen, in 1806 Oersted became professor of physics there. He is regarded as the father of electromagnetism, the fundamental principle of which he discovered, i.e. that a magnetic needle turns at right angles to an electric current. He was the first to isolate the metal aluminium. The *oersted* is the c.g.s. electromagnetic unit of magnetising force.

Ohm, Georg Simon

German physicist

b. Mar. 16, 1787, Erlangen

d. July 7, 1854, Munich

Educated at Erlangen, Ohm eventually became professor of physics at Munich in 1849, a tardy recognition of his great work in electricity, which was little appreciated at the time. The practical unit of electrical resistance is named after him, on account of his discovery of the famous law, named after him also, relating resistance to voltage and current. He worked also on acoustics and crystal interference, and was awarded the Copley medal in 1841

Olbers, Heinrich Wilhelm Matthäus
German astronomer

b. Oct. 11, 1758, Arbergen, nr. Bremen

d. Mar. 2, 1840, Bremen

Educated at Göttingen as a medical student, Olbers turned to astronomy. He is famous for his discovery of asteroids Pallas and Vesta (1802 and 1807) and comets, and for his theory on comets' tails in which he anticipated the much later discovery of radiation pressure (see Fitzgerald; Maxwell; Poynting). He was the first to point out that either light is dimmed by its passage through space or the universe is finite. He explained asteroids as the products of disintegration of planets, and evolved an accurate method of determining the orbit of a comet.

Olszewski, Karol Stanislov

Polish chemist

b. 1846.

d. 1915

Professor of chemistry at the University of Cracow, with Wroblewski, Olszewski succeeded in 1883 in liquefying nitrogen on a large scale.

Onnes, Heike Kamerlingh

Dutch physicist

b. Sept. 21, 1853, Groningen

d. Feb. 21, 1926, Leyden

Educated at Groningen and Heidelberg, Kamerlingh Onnes became professor of experimental physics at Leyden in 1882. He was the founder of the Cryogenic Laboratory in Leyden, and worked on critical phenomena and low temperatures, being the first (in 1908) to liquefy helium, in course of which he reached temperatures lower than 1°K . He discovered the phenomenon of superconductivity at low temperatures, and was awarded the Nobel prize for physics in 1913. It was in his laboratory also that hydrogen was first liquefied (1906).

Oppenheimer, J. Robert

American physicist

b. Apr. 22, 1904, New York

Oppenheimer studied at Harvard, Cambridge and Göttingen, before going to the National Research Council, and to the University of California (1929-47). He was director of the Los Alamos laboratory, New Mexico (1943-45), and in 1947 was appointed director of the Institute for Advanced Studies, Princeton. He has done distinguished work on nuclear disintegration, quantum theory, cosmic rays, and relativity, and was in charge of production of the atomic bomb. In 1954 he was suspended from official duties because of his attitude to the development of the hydrogen bomb.

Orr, John Boyd, Lord

Scottish biologist

b. Sept. 23, 1880, Kilmaurs, Ayrshire

Educated at Glasgow, Orr became an F.R.S. in 1932. He was director of the Rowett Research Institute at Aberdeen and became Chancellor of Glasgow University in 1946. He is noted for his work on animal nutrition and has served on many government commissions in connection with the development of fat stock and food. He was first Director-general of the United Nations Food and Agricultural Organisation, was created Baron in 1949, and gained the Nobel peace prize for 1949.

Osler, Sir William

British physician

b. July 12, 1849, Bond Head, Canada

d. Dec. 29, 1919, Oxford

Educated at Toronto and McGill Universities, Osler studied also in London, Leipzig and Vienna. He became professor of medicine successively at McGill (1875-84), Pennsylvania (1884-88) and the Johns Hopkins University (1889-1905), finally going to Oxford (1905-19). He was created baronet in 1911. Osler was an authority on the spleen and also on the heart, making a special study of angina pectoris, and he was also keenly interested in the history of medicine, upon which he wrote several books. The widely-known

Principles and Practice of Medicine (1892) is still a standard textbook. He was the most brilliant and influential teacher of his day.

Ostwald, Wilhelm

German chemist

b. Sept. 2, 1853, Riga

d. Apr. 3, 1932, near Leipzig

Educated at Dorpat, Ostwald became professor of chemistry in first Riga, then Leipzig (1887-1906) and was awarded the Nobel prize for chemistry in 1909. He carried out important researches on affinity and mass action and did much to propagate the theories of solution suggested by Arrhenius. The discoverer of the dilution law which bears his name, he stated the relationship between molecular conductivity and dilution. His work on the catalytic oxidation of ammonia in connection with the production of nitric acid had great industrial importance, as it led directly to the synthetic production of nitrates. Under him the laboratory at Leipzig climbed to pre-eminence in the scientific teaching world, and his must be regarded as one of the great names in electro-chemistry. He advocated a philosophical monism.

Otto, Nikolaus August

German engineer and inventor

b. 1832

d. 1891

An early pioneer in the production of an internal combustion engine, Otto produced a model (with Langen) in 1867. In 1876 he invented the first four-cycle gas engine, known as the Otto motor.

Oughtred, William

English mathematical writer

b. Mar. 5, 1575, Eton

d. June 30, 1660, Albury, Surrey

Educated at Eton and Cambridge for the Church, Oughtred wrote many books on mathematics and was the first to introduce the multiplication and proportion signs, in *Clavis Mathematica* (1631), a text-book on arithmetic. He also introduced the shortened forms of the trigonometrical functions *sin*, *cos*, etc. He invented the

OWEN

slide-rule, but, owing to his reluctance to publish his discoveries, he became involved in a controversy with Gunter, who also invented it independently about the same time.

Owen, Sir Richard

British physiologist

b. July 20, 1804, Lancaster

d. Dec. 18, 1892, Sheen, Surrey

Educated at Edinburgh, Paris and London, Owen became assistant at the Hunterian Museum. He was professor of anatomy and physiology at the Royal College of Surgeons. He did research work on the teeth of mammals, which led him into palaeontology, and he made himself an authority on this subject. As director of natural history at the British Museum he was responsible for the transfer to South

Kensington, and the magnificent museum there is largely due to his efforts. He made some remarkable reconstructions of prehistoric animals and birds.

Owens, Robert Bowie

American chemist and engineer

b. Oct. 29, 1870, Maryland

d. Nov. 1, 1940.

Educated at the Johns Hopkins, Columbia and McGill universities, Owens became professor of engineering at Nebraska and went from there to McGill University and later to Philadelphia. He was the first to detect thorium emanation, and the inventor of an electromagnetic direction control system for navigation, a differentiation machine, and an electric accelerometer. The discovery of alpha-rays is sometimes attributed to him (see E. Rutherford).

P

Palissy, Bernard

French potter and natural philosopher

b. c. 1510, Agen

d. 1589, Paris

Noted most for the introduction into French pottery of his faience rustic reliefs, Palissy studied also natural science, and was one of the first to appreciate the true nature of fossils and to understand the formation of underground springs. He wrote on ceramics, agriculture, natural philosophy and religion, and led a stormy life struggling against extreme poverty and political persecution (he was a Huguenot), and he died in the Bastille of Bucy while under sentence of death. His poverty is illustrated by the fact that at one time he had to use the floor-boards of his house to fire his furnace, yet his final success with his enamels (1557) gained him royal favour and special exemption from the massacre of St. Bartholomew.

Paneth, Frederick Adolphus

Austrian-British chemist

b. Aug. 31, 1887, Vienna

Educated at Vienna, Munich and Glasgow, Paneth became professor of chemistry at Durham in 1939 after holding similar appointments at Prague, Hamburg, Berlin and elsewhere. He improved the technique for the isolation and measurement of minute traces of helium, and succeeded in estimating amounts as small as 10^{-10} c.c. He did research on the age of rocks by measuring the helium formed by the break-up of radium, and he also examined meteorites to obtain their helium ratios and so estimated their ages.

Panhard, René

French engineer and inventor

b. 1841

A pioneer in the production of motor-cars, with Levasseur, Panhard was the first to construct a chassis (in 1891); and they devised the transmission gear much as we

know it now. He was the founder of the Panhard Company.

Papin, Denis

French physicist

b. Aug. 22, 1647, Blois, Loir et Cher

d. 1712, London

After studying under and assisting Huygens, Papin was elected F.R.S. in 1681 and became professor of mathematics at Marburg in 1687. While in England he was associated with Boyle and was the inventor of a piece of apparatus known as Papin's Digester (1679) by which the temperature of water may be raised to 200°C . before boiling, by subjecting it to a pressure of about 200 lbs. per sq. inch (16 atmos.). He was the first to suggest air pressure as a source of motive power, invented the safety valve and explained the principle of the siphon.

Pappus, Alexandrinus

Greek mathematician

c. 3rd to 4th century

There is considerable doubt as to the exact time in which Pappus, the last of the great Greek mathematicians, lived, but in his famous and comprehensive *Mathematical Collection*, much of which has been lost, he surveys the whole subject up to the end of the third century, and adds much original work. From his book is derived most of our knowledge of Greek geometry. A well-known geometrical theorem, which he discovered, is named after him, and he studied also conics.

Paracelsus, Philippus Aureolus (Theophrastus Bombastus von Hohenheim)

Swiss alchemist and physician

b. 1493, Einsiedeln, Switzerland

d. 1541, Salzburg, Austria

Taught some medicine and chemistry by his father and at the university of Basle, Paracelsus acquired a knowledge of minerals at the Tyrol mines, and thus



PHILIPPUS PARACELSUS, the last of the alchemists.

equipped, and sustained by his own aggressive and independent character, he became town physician and professor of medicine at Basle. His first lecture was rendered spectacular by the burning in sulphur and nitre of the works of Galen and Avicenna, in the hope that the authors were similarly placed. After a dispute about a fee for three pills he was driven from the city and led a miserable, wandering, drinking life before settling at Salzburg. Though a believer in astrology and various forms of magic, Paracelsus had some considerable success owing to his introduction of new medical cures, including mercury, opium, arsenic, sulphur, iron, and mineral baths, and he emphasised the use of chemicals in medicine. In his early wanderings and practice he acquired a long array of empirical facts which he applied with ingenuity and skill. He was the first to use the term *alcohol*, and the first in Europe to mention the metal *zinc*. In opposition to the humoral theory, he declared that diseases were specific and advocated specific remedies. The bitter enmities he aroused were as much the result of his vanity and arrogance as of his scorn for Galen and tradition.

Paré, Ambroise

French surgeon

b. 1509, Laval, Mayenne

d. Dec. 22, 1590, Paris

Trained in Paris, Paré became an army surgeon and is remembered for his new treatment of wounds. He tied up the arteries with ligatures instead of cauterising with red-hot irons or boiling oil, as had been the custom. His many improvements in operative methods have earned for him the title of father of modern surgery. He was surgeon to Henry II and his three successors to the throne, and wrote books on many aspects of his subject.

Parkes, Alexander

English chemist and inventor

b. Dec. 29, 1813, Birmingham.

d. June 29, 1890, West Dulwich, London

Trained in industrial chemistry, Parkes was noted for his numerous inventions in connection with electro-plating in which he was an expert. He even succeeded in plating flowers and a spider's web. He also was the inventor of xylonite (celluloid), the prototype of which he prepared by dissolving nitro-cellulose in alcohol and mixing with camphor.

Parkinson, James

English physician

b. 1755

d. 1824, London.

Parkinson gave in 1817 the first description of paralysis agitans or shaking palsy (Parkinson's disease), due to degeneration of the nerve-cells at the base of the brain. In 1812 he described appendicitis and perforation; and he also wrote on palæontology.

Parkinson, John

English botanist

b. 1567, Nottinghamshire (?)

d. 1650, London

A herbalist who became king's apothecary, Parkinson published *Theatrum Botanicum* (1640) which contained a new classification of plants and included most of L'Obel's work. Parkinson's earlier work, *Paradisi*

in sole *Paradisus Terrestris* (1629), was equally well-known (*Paradisi in sole* = Park-in-son's).

Parsons, Sir Charles Algernon

English inventor

b. June 13, 1854, London

d. Feb. 11, 1931, Kingston, Jamaica

The youngest son of Lord Rosse of telescope fame, Parsons was educated at Dublin and Cambridge. He entered the engineering works of Armstrong at Newcastle and is famous for his development of the steam turbine which was at first (1884) constructed as a turbo-generator. In 1894 he took out a patent for its application to ship propulsion and the first ship so driven was the *Turbinia* (1897). A geared turbine was brought out in 1910, and he also invented anti-skid motor chains.

Parsons, Charles Lathrop

American chemist

b. Mar. 23, 1867, New Marlboro, Mass.

Educated at Cornell University, Parsons became professor of chemistry at New Hampshire and later chief at the U.S. Bureau of Mines. He retired in 1919 to conduct private research. He was the recipient of many high honours in the chemical world, in particular for his original work on beryllium.

Pascal, Blaise

French mathematician and philosopher.

b. June 19, 1623, Clermont Ferrand, Auvergne

d. Aug. 19, 1662, Paris

Educated at home, Pascal showed early signs of genius and at the age of sixteen had written a remarkable treatise on conic sections. He solved many of the outstanding problems of the time, including that of quadrature of the cycloid, and also wrote a treatise on the equilibrium of fluids which marks him as one of the founders of hydrodynamics. He contributed to the differential calculus, and with Fermat founded the theory of probability. Another discovery of his was the fact that the height of a barometric mercury column decreases with altitude, demon-



LOUIS PASTEUR.

strated by the famous Puy de Dôme experiments (1648). He took a prominent part in contemporary arguments concerned, with religious philosophy, and spent long periods in the monastery of Port Royal. From the date of his entry there (1655) his main output was literary; his *Letters to a le Provincial* (1656ff.) subjects the Jesuit tenets to a refinement of irony and felicity of argument that ensures it a high place in literary estimation. The famous *Pensées* was published in a garbled form seven years after his death. Ill-health was his constant companion during the whole of his life, brought on largely by overstudy in his youth.

Pasteur, Louis

French biologist

b. Dec. 27, 1822, Dôle, Jura

d. Sept. 28, 1895, Villeneuve l'Etang, nr Paris

After study in Paris, Pasteur became professor of physics at Dijon in 1848, professor of chemistry at Strasbourg in 1852, in 1857 director of the *École Normale* at Paris, and in 1867 professor at the Sorbonne. The founder of microbiology, he was eventually established in the Pas-

PAULI

teur Institute, built by public subscription in 1889. His early work was chemical and he contributed to establishing stereochemistry by his work on racemic acid and the optical activities of tartaric acid, but his fame chiefly rests upon his discovery of the part played by bacteria in fermentation. He discovered that micro-organisms in yeasts are the cause of the formation of alcohol from sugar and explained in a similar way the production of vinegar from alcohol and the rancidity of butter. He helped to prove that bacteria are not spontaneously generated from non-living matter, and thus stimulated the germ theory of infection. The process of killing harmful bacteria in liquids, for example milk, by holding them at a definite temperature for a given time is known as pasteurisation. In particular it kills tubercle bacilli. In 1857 he showed that lactic acid in milk is formed by micro-organisms. In 1865 he discovered the bacilli of two silkworm diseases; he traced anthrax to bacteria and evolved a method of inoculation; and in 1885 successfully treated the much-dreaded hydrophobia by similar methods. He demonstrated the efficacy of vaccina-



IVAN PAVLOV: his dogs trusted him so much that they jumped on to the table of their own accord, and were never tied.

tion, with an attenuated culture of bacilli as a prophylactic and thus opened a fruitful line of advance against diphtheria, cholera, yellow fever, plague, and tubercular infections. See study by Valéry-Radot (Paris, 1923).

Pauli, Wolfgang

Austrian-Swiss physicist

b. Apr. 25, 1900, Vienna

Educated at Munich, Pauli has occupied several high academic posts on the continent, at Copenhagen, Hamburg, Zürich (since 1927), and was visiting professor of physics at Princeton in 1935, and again in 1940. He is famous for his work on the quantum theory and the exclusion principle, which concerns the number of electrons that can occupy the same energy level in relation to an atomic nucleus. For this work he was awarded the Nobel prize for physics in 1945. He also contributed to matrix mechanics, being first to apply matrices to the spin of the electron in the hydrogen atom.

Pauling, Linus Carl

American biochemist

b. Feb. 28, 1901, Portland, Oregon

After studying at the Oregon State College and later at Munich, Copenhagen and Zürich, Pauling held many high academic appointments and went to the California Institute in 1931. He did notable work on line spectra and the application of the quantum theory to chemistry, on molecular structure and on valency, in which he introduced the idea of resonance. With Campbell and Pressman he produced synthetic antibodies (bodies which fight microbes).

Pavlov, Ivan Petrovitch

Russian physiologist

b. Sept. 14, 1849, Ryazan

d. Feb. 27th, 1936, Leningrad

Educated at St. Petersburg, Pavlov became director of the department of physiology, Institute of Experimental Medicine (1891). In his earlier researches he discovered nerve fibres affecting the action of the heart, and later (1888) the secretory nerves of the pancreas, and he continued to

study the physiology of the digestive glands till 1906. For this outstanding work he was awarded the Nobel prize for medicine in 1904. In 1907 he turned to the study of conditioned reflexes, induced automatic responses to specific stimuli, which he had observed earlier. These, in conjunction with experimental operations on live dogs, Pavlov used to map out the physiology of the brain, showing that such reflexes are associated with definite areas of the cortex. Before his death he was applying the conditioned reflex to psychiatric research. He was awarded the Copley medal in 1915. Most of Pavlov's work entailed the measuring of body secretions, digestive juices, saliva of his dogs, and his brilliant experimental operative technique, to which he owed so much of his success, ranks as one of the major achievements of modern surgery, and firmly established the necessity of preserving normal conditions in experimental work. Pavlov was a complete mechanist, believing that all action depends on conditioned reflex, even such concepts as 'freedom,' 'curiosity,' 'purpose' and 'religion,' and that the brain's functions were the forming and correlating of such reflexes. His work has been accepted into the Marxist canon.

Pecquet, Jean
French anatomist
b. 1622, Dieppe
d. Feb., 1674, Paris

At Montpellier in 1647 Pecquet was the first to see the thoracic duct clearly. He traced the lacteal vessel and discovered Pecquet's reservoir (*cistern chyli*). Like Aselli he worked on dogs, but the extension of his researches was unfortunately stopped by his becoming a dipsomaniac.

Peligot, Eugène Melchior
French chemist
b. 1811, Paris
d. 1890, Paris

Educated in Paris, after financial difficulties had interrupted his studies Peligot was able to continue under Dumas. He became professor of analytical chemistry and glass-making at the Central School of Arts and Manufactures, and was the first to

isolate metallic uranium by heating the anhydrous chloride with potassium in a closed platinum crucible, a dangerous but successful method.

Pelletier, Pierre Joseph
French chemist
b. Mar. 22, 1788, Paris
d. July 20, 1842, Paris

Professor and later assistant director at the School of Pharmacy, Paris, with Caventou, Pelletier was responsible for the naming of chlorophyll and the discovery of quinine and strychnine and other alkaloids. With Walter in 1836 he obtained toluene by distilling pipe resin.

Peltier, Jean Charles Athanase
French physicist
b. Feb. 22, 1785, Ham, Somme
d. Oct. 27, 1845, Paris

After being a watchmaker in Paris, Peltier took to scientific studies and discovered the Peltier effect, a thermo-electric reduction of temperature. Lenz succeeded in freezing water by this method.

Penny, Thomas
English clergyman and botanist
d. 1589

Educated at Cambridge, Penny entered the Church and became a prebendary of St. Paul's. He took an interest in botany and entomology and assisted Gesner in his work. Penny's drawings passed into the hands of Moffet on his death and were used in the latter's *Insectorum Theatrum* (1634). Penny therefore may be regarded as one of the founders of entomology. *Hypericum balearicum* was originally named *Myrtocistus Pennaei* by Clusius in honour of its discoverer.

Peregrinus, Petrus (Peter the Pilgrim, Peter de Maricourt)
French scientist and soldier
c. 13th century

A native of Picardy who took part in the crusades, Peregrinus was the first to mark the ends of a round natural magnet to which he gave the name poles. He stated the laws of attraction between poles and invented a compass with a graduated scale.

PERKIN

Perkin, Sir William Henry (Senior)
English chemist

b. Mar. 12, 1838, Shadwell, London

d. July 14, 1907, Sudbury, Middlesex

After studying chemistry under Hofmann in London, Perkin became Hofmann's assistant. He built a small laboratory at home and there made his epic discovery of mauve, the first aniline dye, in 1856 when he was eighteen. He then gave up his college post and set up a chemical factory, inaugurating the aniline dye industry. He synthesised many substances such as tartaric acid (with Duppa) in 1861, and coumarin, and discovered the Perkin reaction for the condensation of unsaturated aromatic acids.

Perkin, William Henry (Junior)
English chemist

b. June 17, 1860, Sudbury, Middlesex

d. Sept. 17, 1929, Oxford

Trained at the Royal College of Science, Perkin held many professorial posts at English universities, finally going to Oxford in 1912. He is famous for his synthesis of many organic compounds and plant products, for example camphor and its derivatives in 1897, various alkaloids (strychnine, etc.) and terpenes.

Perrin, Jean Baptiste
French physicist

b. Sept. 30, 1870, Lille.

d. 1942

Educated at Paris, Perrin became professor of the physical chemistry department of the University of Paris. An authority on X-rays and similar radiations and on the discontinuity of matter, he was awarded the Nobel prize for physics in 1926 for this and for his discovery of the equilibrium of sedimentation. He has written text-books on physical chemistry and physics, e.g. *Les Éléments de la Physique* (1930).

Peter de Maricourt, or Peter the Pilgrim. See *Peregrinus*, *Petrus*.

Petit, Alexis Thérèse
French physicist

b. Oct. 2, 1791, Vesoul, Haute-Saône

d. June 21, 1820, Paris

A professor of physics at the Lycée Bonaparte, Petit discovered with Dulong the law named after them, stating that the product of the specific heat and the atomic weight is the same for all elementary substances. He studied thermal expansion and the specific heats of solids.

Petit, Jean Louis

French surgeon

b. Mar. 13, 1674, Paris

d. Apr. 20, 1750, Paris

The foremost surgeon of his day and an F.R.S., Petit was the inventor of the screw tourniquet and the first to operate successfully for mastoiditis (by trephining).

Pettersson, Sven Otto

Swedish chemist

b. 1848

d. Jan. 6, 1941, Göteborg

Professor of chemistry at Stockholm until 1908, Pettersson is noted for his researches (with Nilson) on titanium and germanium. He evolved a method for the determination of dissolved gases in sea-water and made other contributions to oceanography.

Pettit, Edison

American astronomer

b. Sept. 22, 1890, Peru, Nebraska

After studying at the State Normal College, Peru, and at Kansas and Chicago, Pettit taught astronomy at these colleges before going to the Yerkes Observatory and then to Mount Wilson (1920) as astronomer. He is famous for his work on the sun and formulated laws alleged to govern the movement of prominences. For this research he constructed the interference polarising monochromator, and introduced the use of motion pictures in this line of study. He also carried out research on ultra-violet light with reference to biology, and with Nicholson devised a sensitive thermocouple to register changes in temperature as small as three hundred thousandths of a degree, an instrument which has proved its usefulness in measuring the surface temperatures of planets. He studied the radiations of planets, and wrote *Forms and Motions of the Solar Prominences* (1925).

Pfeffer, Wilhelm

German botanist

b. Mar. 9, 1845, Grebenstein, nr. Cassel

d. Jan 31, 1920, Cassel

Professor of botany successively at Bonn, Basle, Tübingen and Leipzig, Pfeffer was one of the first to prepare a semi-permeable membrane in 1877 and so measure the osmotic pressure of solutions. He made researches on which the modern theory of solutions is based, and found that for dilute sugar solutions the osmotic pressure is proportional to the concentration. With Julius Sachs he conducted important researches fundamental to plant physiology, and wrote a standard *Handbuch der Pflanzenphysiologie* (1881).

Pfeiffer, Richard Friedrich Johann

German bacteriologist

b. 1858

After being assistant to Koch and holding various academic posts, Pfeiffer was professor at Breslau from 1909 to 1926. He found Pfeiffer's bacillus in influenza (1892) and the *Micrococcus catarrhalis*. He worked on Pfeiffer's reaction for cholera and laboured to find a serum specific against influenza.

Pflüger, Eduard Friedrich Wilhelm

German physiologist

b. June 7, 1829, Hanau

d. Mar. 16, 1910, Bonn

A pupil of Ludwig and Johannes Müller, and professor at Bonn (1859), Pflüger helped in the construction of the mercurial blood-pump and conducted very important researches on the physiology of breathing. He showed that oxidation takes place in the tissues and not in the blood, and also that within wide limits the consumption is unaffected by the oxygen concentration but depends on the requirements of the organism. He pursued researches on the spinal cord, the motor system and electrical stimulus, and on the digestive and metabolic systems.

Phillips, John

English geologist

b. Dec. 25, 1800, Marden, Kent

.. Apr. 24, 1874, Oxford

In 1834 Phillips became professor of geology at King's College, London, and later occupied a similar chair at Oxford. He introduced the term *Mesozoic* to cover the time between the *Palaeozoic* and the *Cainozoic* eras, which latter he also named.

Philo

Scientist of Byzantium

c. 2nd century B.C.

An early natural philosopher, Philo noticed the contraction of air in a globe over water when a candle was burnt in it. This is probably the earliest record of this experiment. He wrote a treatise on military engineering of which some fragments survive, notably that in a Latin version (*De ingeniiis spiritualibus*), describing Ctesibius' invention of a compressed-air catapult.

Piazzi, Giuseppe

Italian astronomer

b. July 16, 1746, Ponte, Valtellina

d. July 22, 1826, Naples

After holding several academic posts at Italian universities, Piazzi became professor of mathematics at Palermo where he established an observatory in 1789. In the course of making a star catalogue in 1801 he discovered Ceres, the first of the asteroids. In 1817 he became director of the government observatory at Naples.

Picard, Charles Émile

French mathematician

b. 1856

d. 1941

In work on differential equations Picard used a method of successive approximations to establish the existence of solutions and his study of the theory of functions led to the theorem which carries his name, referring to the number of solutions of the general equation $f(z)=A$. Among other works he published, with Simart, *Théorie des Fonctions Algébriques de Deux Variables Indépendantes* (1897-1906).

Picard, Jean

French astronomer

b. July 21, 1620, La Flèche, Anjou

d. Oct. 12, 1682, Paris

PICCARD

From theology Picard turned to astronomy and visited Tycho Brahe's observatory at Uraniborg, making a determination of its longitude. He measured a degree of the meridian in France, the first accurate measurement, and so arrived at a value for the size of the earth. Newton used his results in his work on gravitation.

Piccard, Auguste

Swiss physicist

b. Jan. 28, 1884, Lutry, Vaud

Educated at Basle and Zürich, Piccard became professor of physics at Brussels until obliged to leave for Switzerland owing to the German invasion. He is famous for his pioneer exploration of the stratosphere for which he constructed a special balloon having a spherical metal airtight gondola attached. He reached a height of 15,781 metres in 1931 and 16,940 metres in the following year. In 1948 he constructed a bathysphere for the exploration of the deep sea and after early failures reached a depth of over 10,000 feet in the Mediterranean (1953).

Pickering, Edward Charles

American astronomer

b. July 19, 1846, Boston

d. Feb. 3, 1919, Cambridge, Mass.

Educated at Harvard, Pickering became professor of physics at the Massachusetts Institute of Technology. In 1876 he became professor of astronomy at Harvard. He invented the meridian photometer, with which he measured the exact magnitude of over 4,000 stars. A pioneer in stellar spectroscopy, he was responsible for the classification of stellar spectra, of which 225,000 were examined. (See also below).

Pickering, William Henry

American astronomer

b. Feb. 15, 1858, Boston, Mass.

d. 1938

Younger brother of E. C. Pickering (above), W. H. Pickering was educated at the Massachusetts Institute of Technology and became assistant to his brother at Harvard. He collaborated with Lowell in observations on Mars, and is known for his discovery in 1898 of the ninth satellite

of Saturn (Phoebe). He discovered also a tenth (Themis) which has not been confirmed.

Pictet, Raoul Pierre

Swiss physicist

b. Apr. 4, 1846, Geneva

d. July 27, 1929, Paris

From the chair of physics at Geneva, Pictet went in 1886 to Berlin and later to Paris. He experimented on the liquefaction of gases and in 1877 was the first to liquefy oxygen. He found it a beautiful blue liquid which can be placed in the hand quite safely despite its low temperature. He liquefied also nitrogen, hydrogen and carbon dioxide, and studied low temperature phenomena.

Planck, Max Karl Ernst Ludwig

German physicist

b. Apr. 23, 1858, Kiel

d. Oct. 4, 1947, Göttingen

After studying at Munich and Berlin and being professor of physics at Berlin (1889), Planck became permanent secretary of the Prussian Academy of Sciences. He is famous for his presentation in 1900 of the quantum theory and was awarded the Nobel prize for physics in 1918, becoming F.R.S. in 1926. In 1926 he went to the Kaiser-Wilhelm Institute, becoming its president in 1930. From 1945 he lived in Göttingen, opposed to Nazi theories, and in later years his mind turned increasingly to problems of philosophy and causality. Though he did distinguished work on thermodynamics and mechanics, and on optics and radiation in the light of relativity, the quantum theory alone is sufficient to place him among the outstanding figures of modern mathematical physics. His books include *Einführung in die theoretische Physik* (1916-30), and *Wege zur physikalischen Erkenntnis* (1933). The quantum theory, developed from his work on black-body radiation, is one of the most fertile of modern physical hypotheses, postulating the transmission of energy in a system showing a natural frequency in definite quanta or instalments. Planck's constant of angular momentum is the unit of this quantity (6.62×10^{-27} erg seconds).

The resolution of quantum-wave duality is the subject of quantum-mechanics.

Planté, Gaston
French physicist

b. 1834

d. 1889

Following up Ritter's discovery of the secondary cell, Planté constructed the first primitive accumulator, consisting of rolled lead sheets in dilute sulphuric acid (1860).

Plateau, Joseph Antoine Ferdinand
Belgian physicist

b. Oct. 14, 1801, Brussels

d. Sept. 15, 1883, Ghent

Professor of physics at Ghent from 1835, Plateau was the discoverer of the tiny second drop, named after him, which always follows the main drop of liquid falling from a surface. He damaged his eyesight by looking at the sun for twenty seconds to discover the effect on his eye, and his sight gradually deteriorated until he became blind. His scientific work continued, however, as he directed many experiments using the eyes of others to observe the results. He is famous for his researches on physiological optics and molecular physics.

Playfair, John
Scottish mathematician and geologist
b. Mar. 10, 1748, Benvie, Forfarshire

d. July 20, 1819, Edinburgh

Educated at St. Andrews, Playfair became assistant professor of mathematics at Edinburgh in 1785 and professor of natural philosophy in 1805. He was elected F.R.S. in 1807. His famous axiom that two intersecting straight lines cannot both be parallel to a third straight line has taken its place in many geometry books. He was a great supporter of the geologist Hutton, and was largely responsible for the acceptance of the Huttonian theory of the earth (*Illustrations to the Huttonian Theory*, 1802).

Plücker, Julius
German mathematical physicist
b. July 16, 1801, Elberfeld
d. May 22, 1868, Bonn



MAX PLANCK has been called 'the most revolutionary of all human thinkers'.

Educated at Bonn, Heidelberg, Berlin and Paris, Plücker became professor of mathematics at Bonn in 1836 and professor of physics in 1847. He evolved six equations, named after him, concerning algebraic curves. He investigated diamagnetism as well as originating the idea of spectrum analysis. In 1859 he discovered cathode rays, produced by electrical discharges in gases at low pressures.

Poggendorff, Johann Christian
German physicist

b. Dec. 29, 1796, Hamburg

d. Jan. 24, 1877, Berlin

After studying physics and chemistry Poggendorff was professor at Berlin from 1834 until his death. He introduced the small mirror on a suspended system which reflects a beam of light on to a scale, to magnify small deflections. This is used in mirror galvanometers, etc. He studied magnetism and electricity and scientific biography and history.

Poincaré, Jules Henri
French mathematician
b. Apr. 29, 1854, Nancy
d. July 17, 1912, Paris

POISSON

After studying at the École Polytechnique Poincaré became a professor in Paris of mathematical physics and astronomical mechanics. He is famous for his work on the theory of functions and on differential equations, and also did much on the theory of orbits in connection with the astronomical problem of three bodies. This latter work earned him a European prize offered by the King of Sweden. He worked also on the electromagnetic theory of light and on Hertzian waves, and it was a suggestion of his that led Becquerel to his discoveries in radioactivity.

Poisson, Siméon Denis

French mathematician

b. June 21, 1781, Pithiviers, Loiret

d. Apr. 25, 1840, Paris

During his medical studies, when he was seventeen, Poisson's first patient died under his ministrations and he not unnaturally took a dislike to the profession. He changed to mathematics, entering the École Polytechnique in 1798 and succeeding Fourier as professor there in 1808. In 1809 he was the first professor of mechanics at the Sorbonne. He is famous for his work on mathematical physics and was the discoverer of a well-known equation concerning electrical potential. From theoretical consideration of the wave theory of light he deduced the bright spot at the centre of the shadow of a small opaque object, a deduction which seemed to him so absurd that he rejected the wave theory. As a matter of fact this bright spot had been observed but not understood by Delisle in 1715. He experimented on the elasticity of materials, and gave his name to the ratio between the lateral and longitudinal strain in a wire, etc. He studied also the calculus of variations, Fourier's series, heat, acoustics, and capillarity.

Polanyi, Michael

Hungarian physical chemist

b. Mar. 12, 1891, Budapest

Educated at Budapest, Karlsruhe and Berlin, Polanyi came to England from the Kaiser Wilhelm Institute and became professor of physical chemistry at Man-

chester in 1933. He was elected F.R.S. in 1944, and in 1947 became professor of social studies at Manchester. He left Germany on account of Nazi racial persecution, and has written several books in connection with freedom of scientific thought and others upon technical subjects. He has done notable research upon reaction kinetics and crystal structure by X-ray analysis.

Poncelet, Jean Victor

French mathematician and engineer

b. July 1, 1788, Metz

d. Dec. 22, 1867, Paris

Educated at Metz, Poncelet became an army engineer, being at one time a prisoner of war in Russia. During his imprisonment he began to study geometry, and later produced his famous work on projective geometry, *Traité des Propriétés Projectives des Figures* (1822). He thus ranks with Monge, the founder, in the development of this new geometry. He held several academic appointments in Metz (1815-35) and Paris (1838-48).

Popov, Aleksandr Stepanovich

Russian physicist

b. 1859

d. 1905

A pioneer in radio-telegraphy, Popov was the first to use a suspended wire as an aerial. He also invented a type of coherer using sensitive filings for the detection of wireless waves. On account of his discoveries in this field he is claimed by the Russians to be the inventor of wireless telegraphy.

Pouillet, Claude Servais Matthias

French physicist

b. Feb. 16, 1790, Cusance (Doubs)

d. June 14, 1868, Paris

Professor of physics in Paris (1838), in 1839 Pouillet invented the tangent and sine galvanometers and a pyrheliometer.

Poynting, John Henry

English physicist

b. Sept. 9, 1852, Monton, Lancs.

d. Mar. 30, 1914, Birmingham

Educated at Manchester and Cambridge,

Poynting became professor of physics at Birmingham in 1880, and was elected F.R.S. in 1888. In 1893 he determined the constant of gravitation by a torsion experiment. He showed that for finely divided matter light-pressure could be greater than gravity, and so explained the phenomenon of a comet's tail always pointing away from the sun. With J. J. Thomson he published a *Textbook of Physics* (1899-1914).

Pregl, Fritz

Austrian chemist

b. Sept. 3, 1869, Laibach (Ljubljana, Yugoslavia)

d. Dec. 13, 1930, Graz

After study at Graz, Tübingen, Leipzig and Berlin, Pregl rose to be professor of applied medical chemistry at Innsbruck, and finally at Graz. He is remembered for his micro-chemical methods of analysis, conducting analysis with as little as from 3 to 5 milligrammes of material. For this research he was awarded the Nobel prize for chemistry in 1923.

Prévost, Pierre

Swiss physician, classicist and litterateur

b. Mar. 3, 1751, Geneva

d. Apr. 18, 1839, Geneva

After studying theology, law and medicine, Prévost occupied chairs of philosophy and physics at Berlin and Geneva. In 1792 he proposed the theory of exchanges in connection with the laws of radiation. He wrote and translated much on many subjects, including physics and philosophy.

Priestley, Joseph

English chemist

b. Mar. 13, 1733, Fieldhead, Yorks.

d. Feb. 6, 1804, Northumberland, Pa.

After a theological training Priestley became a nonconformist minister. His first scientific interest was in connection with electricity, but he later turned to chemistry and especially to the study of gases since, living near a brewery, he observed the production of 'fixed air', carbon dioxide, in fermentation. In 1772 he invented a method of making soda-water. He was greatly helped financially



JOSEPH PRIESTLEY, the non-conformist clergyman who discovered oxygen.

by his friendship with Lord Shelburne, afterwards Prime Minister, whose librarian he was at one period. His liberal theological and political opinions and support of the French Revolution laid him open to much persecution, including even the burning of his house and laboratory. This persecution eventually drove him to America in 1794, where he later declined the professorship of chemistry at Philadelphia. He believed in the theory of phlogiston even though his discovery of oxygen (1774; after Scheele) had in fact disproved it, and called his discovery 'dephlogisticated air' (see J. Mayow). He made many experimental mistakes and often drew wrong conclusions from his work but was honest enough to recognise and admit his own limitations. As well as oxygen, he discovered ammonia, the oxides of nitrogen, hydrochloric acid gas, nitrogen, carbon monoxide and sulphur dioxide, but not under those names. He also recognised the production of oxygen by green plants in sunlight and the reduction of oxides by hydrogen with the formation of water in the process, but he failed to draw the obvious conclusions as to the composition of water.

PRINGSHEIM

Pringsheim, Ernst

German physicist

b. 1859

d. 1917

In research on spectroscopy Pringsheim conducted investigations on the emission spectra of compounds and came to the conclusion that line spectra, and possibly fluted spectra, are produced only when chemical changes are occurring in the radiating substance. His work with Lummer on black-body radiation influenced Planck.

Pringsheim, Nathanael

German biologist

b. Nov. 30, 1823, Wziesko, Silesia

d. Oct. 6, 1894, Berlin

Educated at Breslau, Leipzig and Berlin, Pringsheim became a professor at Jena for a short period, but did most of his important work on the fertilisation of plants privately. He was the first to see the spermatozooids enter the female cell of a plant. This he did with the fresh-water alga *Vaucheria* in 1855, and he made observations of the complete process as far as the growth of a new plant. Fol in 1879 made parallel observations on animal life.

Proust, Joseph Louis

French chemist

b. Sept. 26, 1754, Angers, Maine-et-Loire

d. July 5, 1826, Angers

Trained as an apothecary, Proust became professor in Madrid (1789-1808). In this latter year the French destroyed his laboratory in the siege of the town. In 1808 on the fall of Charles IV, he returned to France. He recognized the difference between oxides and hydroxides, and in 1797 he stated the law of constant proportion (Proust's law) which led to some controversy with Berthollet in which the latter's theory was shown to be incorrect. He isolated and established the identity of grape sugar.

Prout, William

English physician and chemist

b. Jan. 15, 1785, Horton, Glos.

d. Apr. 9, 1850, London

After his training at Edinburgh and while practising as a doctor in London, Prout became interested in chemistry and was aware of the presence of hydrochloric acid in the stomach. He was the first to suggest the very important hypothesis named after him, which states that all atomic weights are multiples of that of hydrogen, and also that hydrogen is the fundamental element of which all others are composed. He published this in an anonymous paper (1816). The discovery of isotopes has revived this theory after Stas's apparent disapproval.

Ptolemy, or Claudius Ptolemaeus

Greco-Egyptian astronomer

b. c. 90, Ptolemais Hermii (?)

d. 168

One of the Alexandrian school of scientists, Ptolemy wrote a famous book on astronomy known as the *Almagest* (from the Arabic abbreviation for the Greek Μεγάλη σύνταξις τῆς ἀστρονομίας); this was the standard authority until Copernicus and Kepler showed that his conception of the earth as centre of the universe was wrong (Ptolemaic system). In this book Ptolemy divides degrees into minutes and seconds, and gives 3.146 as the value of π but in the form of a fraction $3\frac{1}{25}$; he includes also a catalogue of 1028 stars. This and other parts of the book were probably quotations from Hipparchus. Another of his books was a *Geography* giving a description of the earth and a list of places by latitude and longitude.

Purkinje, Jan Evangelista (also Purkyne)

Czech physiologist

b. Dec. 12, 1787, Libochowitz

d. July 28, 1869, Prague

Professor at Breslau (1823) and Prague (1850), Purkinje was noted for his work on the eye. He has given his name to *Purkinje's figure*, an effect by which it is possible to see in one's own eye the shadows of the retinal blood vessels. He also did work on the brain; Purkinje's cells are situated in the middle cerebellar cortex. He studied also sweat glands, muscles, embryology, and digestion. His discoveries were many and important.

Putnam, Tracy Jackson

American neurologist

b. Apr. 14, 1894, Boston, Mass.

Educated at Harvard, Putnam became pathologist at the Johns Hopkins Hospital, and later, specialising in neurology, he rose to be director of neurology and neuro-surgery at the Neurological Institute, New York (1939). With Dr. H. H. Merritt he isolated from phenobarbital Sodium Dilantin (phenytoin sod.), a corrective for many nervous disorders, such as forms of epilepsy.

Pythagoras

Greek philosopher and mathematician

b. 569 (? 582) B.C., Samos

d. 500 (? 506) B.C., Metapontum

An eminent thinker who set up in southern Italy a school of philosophy and religion which exerted enormous influence on contemporary thought, Pythagoras believed in the transmigration of souls, and as a result was a vegetarian. For the purification of the soul on earth he drew up a comprehensive and strict system of ethics. The influence he exerted on politics led to his murder by a mob incited by his

political opponents. His system, however, retained for two centuries the discipline and ideal of reform he had stamped upon it. The 'Samian sage,' as antiquity knew him, did not publish any books since he regarded his knowledge as secret and exclusive to his disciples, but he is best known for his system of geometry and in particular for his theorem on the squares on the sides of a right-angled triangle. He proved also that the sum of the three angles of a triangle is equal to two right angles. He was the originator of the monochord and the discoverer of the fact that halving a string's length raises it one octave in pitch. His quaint notion that the distances of the planets were in musical progression led to the idea of the harmony of the spheres, and in general he was much exercised by the supposed mystical properties of numbers, which he regarded as the fundamental entity in terms of which all things could be expressed. To his conception of numbers as possessed of shape we owe the terms *square* and *cube*. He and his followers studied mathematics and astronomy, but their contributions to them remain on the whole uncertain.

Q

Quetelet, Lambert Adolphe Jacques

Belgian statistician and astronomer

b. Feb. 22, 1796, Ghent

d. Feb. 17, 1874, Brussels

After being professor of mathematics at Ghent at the early age of eighteen, and at Brussels (1819), Quetelet was director of the new observatory there from 1828 until his death. He carried out versatile researches in mathematics, astronomy, physics and meteorology, but it was his pioneer work on statistics which gained for him an international reputation. He applied the

recently developed calculus of probabilities to sociological studies such as the physical and moral qualities of man, and his *Du système social et des lois qui le régissent* (1848) introduced the concept of 'the average man' to interpret social phenomena. His most important work was *Physique sociale, ou essai sur le développement des facultés de l'homme* (1835). Quetelet's statistical methods were successfully applied later by Galton and others to the problem of the selective action of environment in evolution.

R

Rabi, Isidor Isaac

American physicist

b. July 29, 1898, Rymanow, Austrian Galicia

Leaving Austria in childhood, Rabi was educated at Cornell and Columbia and later at several continental universities. He became professor of physics at Columbia in 1937, and is noted for his work on magnetism, quantum mechanics and nuclear physics, and was awarded the Nobel prize for physics in 1944 for his precision work on neutrons.

Rahn, Johann Heinrich

Swiss mathematician

b. Zürich

d. 1676, Zurich

The town treasurer of Zürich, in 1659 Rahn was the first to use (in *Teutsche Algebra*) the division sign \div ; it was probably a combination of — and : . His book was translated into English.

Raman, Sir Chandrasekhara Venkata

Indian physicist

b. Nov. 7, 1888, Trichinopoly, Madras Pres.

Educated at Madras University, after being professor of physics at Calcutta (1917-33) Raman became director of the Indian Institute of Science at Bangalore. He was knighted in 1929, awarded the Nobel prize for physics in 1930, and became an F.R.S. for his researches on diffraction, oscillation and related topics. The Raman effect (1928) is connected with the frequency of scattered light waves produced by the impact of waves on molecules. He has also done work on the theory of musical instruments.

Ramón y Cayal, Santiago

Spanish histologist

b. May 1, 1852, Petilla de Aragon, Navarre d. Oct. 17, 1934, Madrid

Educated at Saragossa, Ramón y Cayal

became professor of anatomy at Valencia in 1881, moving from there to Barcelona and then to Madrid as professor of histology (1892-1922). His work on the brain and nerves was outstanding. He isolated the neuron, described the primary changes it undergoes, and made important discoveries concerning the structure and connection of nerve cells in grey matter and the spinal cord. He shared with Golgi the Nobel prize for medicine in 1906, and wrote several books on his subject.

Ramsay, Sir William

Scottish chemist

b. Oct. 2, 1852, Glasgow

d. July 23, 1916, High Wycombe, Bucks.

Educated at Glasgow and under Fittig at Tübingen, Ramsay became professor of chemistry at Bristol in 1880 and at University College, London, in 1887. He was knighted in 1902, awarded the Nobel prize for chemistry in 1904, and was president of the British Association in 1911. By spectrum analysis he discovered helium in uranium- and thorium-bearing minerals (see F. Soddy), and in collaboration with Lord Rayleigh in 1894 he discovered argon. Later with Travers he discovered neon, krypton and xenon. He also studied the molecular structure of pure liquids.

Ramsden, Jesse

English mathematical instrument maker

b. Oct. 6, 1735, Salterhebble, nr. Halifax

d. Nov. 5, 1800, Brighton

An optical instrument maker of great reputation, Ramsden married a daughter of Dollond. He became an F.R.S. and is well known as the inventor of an eyepiece which is constructed to contain cross-wires or some such measuring scale. He is even more famous for his introduction of the equatorial mounting for telescopes. With Roy in 1785 he designed a piece of

RANDALL



JOHN RAY, 'the father of English botany'.

apparatus to measure very accurately the expansion of a metal bar. This was in connection with the measurement of a baseline on Hounslow Heath, the occasion being the first systematic survey of the British Isles, conducted by General Roy

Randall, John Turton

English physicist

b. Mar. 23, 1905

Educated at Manchester, Randall worked in the General Electric Laboratories before going to Birmingham University, and then to St. Andrews, and finally London as professor of physics. An F.R.S. in 1946, with Boot in 1940 he designed a cavity magnetron valve for use in radar. This earned for him a government award of £12,000 in 1949. It generates very high power at wavelengths of less than 10 cm.

Raoult, François Marie

French chemist

b. May 10, 1830, Fournes, Nord.

d. Apr 1, 1901, Grenoble

Educated at Paris, Raoult had to take to teaching because of financial difficulties. In 1870 he became professor of chemis-

try at Grenoble. He discovered a law, named after him, relating the vapour pressure of a solution to the number of molecules of solute dissolved in it.

Raschig, Friedrich August

German chemist and industrialist

b. June 8, 1863, Brandenburg

d. Feb. 4, 1928, Duisburg

Educated at Berlin and Heidelberg, Raschig worked at the former university before becoming an industrial chemist. He is famous for his discovery of nitramide and chloramine, and for the introduction of new methods of production for hydroxylamine, hydrazine and phenol.

Rathke, Martin Heinrich

German biologist

b. Aug. 25, 1793, Danzig

d. Sept. 3, 1860, Königsberg

Professor at Dorpat and then Königsberg after Von Baer, in 1829 Rathke discovered gill-slits and gill-arches in embryo birds and mammals. Rathke's pocket, in developing vertebrates, is a small pit on the dorsal side of the oral cavity, marking the point of invagination of the hypophysis.

Ray, John

English naturalist

b. Nov. 29, 1628, nr. Braintree, Essex

d. Jan. 17, 1705, nr. Braintree

Regarded as the father of British natural history, Ray was the son of a blacksmith, was educated at Cambridge and became an F.R.S. in 1667. The Ray Society, named after him, publishes works on botany and zoology. In 1682 he announced the difference between monocotyledons and dicotyledons, and so named them, and he arranged plants according to their structural form, the foundation of the natural system of classification. He gave the word *species* a practical limitation, and after Willughby's death continued his zoological work and brought order to the study of insects. In 1692 he suggested that erosion would eventually reduce the land to sea-level. His main works are *Methodus Plantarum Nova* (1682) and *Historia Generalis Plantarum* (1686-1704).

Rayleigh, John William Strutt, Lord
English physicist
b. Nov. 12, 1842, Terling, Essex
d. June 30, 1919, Witham, Essex
Educated at Trinity College, Cambridge, Rayleigh became professor of experimental physics there in 1879 and professor of natural philosophy at the Royal Institution in 1887. He was secretary to the Royal Society from then until 1896, having been elected a fellow in 1873. In 1908 he was made Chancellor of Cambridge. With Ramsay he discovered the element argon in 1894, and he was awarded the Nobel prize for physics in 1904. In his studies in physical optics he pointed out that to reduce spherical aberration in lenses it is better to use a central stop rather than a peripheral if high resolving power is required. From instantaneous photographs of bursting soap-films he found that the rupture travelled at 33 miles per hour. *Theory of Sound* (1877-8) was an outcome of his earlier researches; and he was concerned also with the fixing of absolute electrical units. He was an original member of the Order of Merit.

Réaumur, René Antoine Ferchault de
French entomologist
b. Feb. 28, 1683, La Rochelle
d. Oct. 17, 1757, La Bermondière, Maine. Trained in a Jesuit school and later at Paris, Réaumur made many observations over a wide range of sciences. He was the inventor of a thermometer scale reading from 0 to 80 for the fixed points, used in some parts of the continent but having nothing to recommend it. His work in biology was outstanding, embracing such diverse subjects as the locomotion of starfish, marine phosphorescence, the effect of heat on insect development, regeneration in the crustacea, artificial incubation, and bees. He contributed also to metallurgy and invented Réaumur's porcelain.

Recordé, Robert
Welsh mathematician and physicist
b. 1510, Tenby, Pembroke
d. 1558, London
Educated at Oxford, Recordé took a

degree in medicine at Cambridge. He became the King's physician to Edward VI and Mary, but died in prison as a debtor. In 1557 appeared his important textbook on algebra, *Whetstone of Witte*, in which the equals sign (=) appears for the first time. This and his other works on arithmetic (*The Grounde of Artes*, 1540), geometry (*Pathwaye to Knowledge*, 1551), and astronomy (*Castle of Knowledge*, 1556) are among the first mathematical textbooks in English. His contribution to the study of algebra was second only to that of Vieta among his contemporaries.

Redi, Francesco
Italian physician and poet
b. Feb. 19, 1626, Arezzo
d. Mar. 1, 1697, Pisa
A physician at Florence, Redi wrote a famous book on animal parasites and, by showing that maggots cannot form on meat which has been covered, did much to disprove the idea of spontaneous generation which was current at the time. Nevertheless he himself believed that gall insects were spontaneously generated.

Reed, Walter
American bacteriologist
b. Sept. 13, 1851, Gloucester County, Va.
d. Nov. 23, 1902, Washington
Educated at Virginia and Bellevue Medical School, Reed was an army surgeon, becoming professor of bacteriology in the Army Medical School. He did important work on typhoid and also on yellow fever, disproving Sanerelli's theory of the latter. He later proved that the parasite of yellow fever was carried by the mosquito *Stegomyia fasciata*, and this knowledge enabled the Americans to stamp out the disease in Cuba and elsewhere. The story of this highly dangerous research, in which some of his co-workers lost their lives by the disease, forms one of the most stirring chapters in the history of medicine.

Regener, Erich
German physicist
b. Nov. 12, 1881, Bromberg
Educated at Berlin, Regener became professor of physics there and later at Stutt-

REGIOMONTANUS

gari. He was dismissed on political grounds in 1937 and reinstated in 1946. He has done pioneer work on cosmic rays, investigating them in deep water and in the stratosphere. His researches on the stratosphere, in the course of which he sent up balloons to a height of over 13½ miles, also include the determination of the oxygen and ozone contents.

Regiomontanus

German astronomer

b. June 6, 1436, Königsberg, Franconia

d. July 6, 1476, Rome

Originally Johann Müller, Regiomontanus renamed himself by Latinising his birthplace. He studied under Purbach in Vienna and published a treatise on trigonometry. In 1471 he went to Nuremberg and erected, under patronage, the first European observatory. He made observations of great importance on Halley's comet which had appeared in 1472, produced several sets of mathematical tables, and invented the method of lunar distances for the determination of longitude at sea used by Columbus. He was engaged in Rome on the reform of the calendar when he was assassinated.

Regnault, Henri Victor

French chemist and physicist

b. July 21, 1810, Aix-la-Chapelle

d. Jan. 19, 1878, Auteuil, nr. Paris

Educated in Paris, Regnault became professor of chemistry there, and professor of physics at the Collège de France in 1840. He was a director of the Sèvres porcelain factory. His researches in thermometry, specific heats, expansion of gases, etc., set the standard for many years, and he designed a piece of apparatus to measure the bulk modulus of a liquid. In chemistry he discovered carbon tetrachloride. One of his pupils was William Thomson, afterwards Lord Kelvin. The results of his later researches were destroyed during the war of 1870.

Reich, Ferdinand

German physicist

b. 1799, Bernburg, Anhalt

d. 1882

Educated at Leipzig, Freiberg, Göttingen and Paris, Reich became professor of physics at the Freiberg School of Mines. With Richter in 1863 he discovered the element indium by spectroscopic analysis, and he worked also on the temperature of rocks at different depths.

Reichenbach, Karl, Baron von

German naturalist and industrialist

b. 1788, Stuttgart

d. 1869, Leipzig

Educated at Tübingen, after a short term of political imprisonment Reichenbach set up manufactories for the distillation of organic substances, and made a large fortune. In 1832 he discovered creosote in wood tar, and also paraffin.

Reinold, Arnold William

English physicist

b. June, 1843, Hull

d. Apr. 11, 1921.

Educated at Oxford, Reinold became professor of physics at the Royal Naval College, Greenwich. With Professor Rücker he used Jamin's interferometer to measure the thickness of a soap film (10^{-6} mm.).

Repsold, Johann Georg

German instrument maker

b. Sept. 19, 1770, Wremen, Hanover

d. Jan. 14, 1830, Hamburg

An engineer and chief of the fire brigade at Hamburg, Repsold was killed by the fall of a wall in a fire. He introduced microscopes on meridian circles, and designed a special pendulum, named after him, for the accurate determination of 'g'.

Reynolds, Osborne

British physicist and engineer

b. Aug. 23, 1842, Belfast

d. Feb. 21, 1912, St. Decumans, Somerset

Educated at Cambridge, Reynolds became professor of engineering at Manchester in 1868, and was a Royal Society gold medallist in 1888. He developed a complete theory of the radiometer, and greatly improved centrifugal pumps, making possible the construction of a high lift pump (1000 ft.).

Rheticus, Georg Joachim (G. J) von
 Lauchen)

German astronomer and mathematician
 b. Feb. 15, 1514, Feldkirch, Vorarlberg
 d. Dec. 4, 1576, Cassovia, Hungary
 After studying at Zürich and Wittenberg Rheticus became professor of mathematics at the latter in 1537. He left for a time to work with Copernicus, whom he encouraged in his efforts, but returned later. He arranged for the publication of the latter's *De Revolutionibus Orbium Coelestium*. He is famous for his trigonometrical tables worked to ten decimal places (1596) and his table of sines to fifteen decimal places (1613), marvels of achievement in their day. He wrote the first account of the Copernican theory, *Narratio prima de libris revolutionum Copernici* (1540).

Rhijn, Pieter Johannes van

Dutch astrophysicist
 b. 1886, Gouda, South Holland
 Educated at Groningen under Kapteyn, Rhijn became his assistant in 1914. He collaborated with Kapteyn in his development of a theory of the universe, and became professor at Groningen on Kapteyn's retirement in 1921. The Kapteyn-van Rhijn universe and the Shapley universe which were at one time considered contradictory are now rather regarded as complementary theories.

Rhine, Joseph Banks

American psychologist
 b. Sept. 29, 1895, Waterloo, Pa.
 After studying at Chicago and Harvard, Rhine became professor of psychology in 1937 at Duke University. He published *New Frontiers of the Mind* in 1937, and *Extra-Sensory Perception* in 1940, and has conducted some remarkable experiments on parapsychology (telepathy and clairvoyance).

Richards, Theodore William

American chemist
 b. Jan 31, 1868, Germantown, Pa.
 d. Apr. 2, 1928, Cambridge, Mass.
 Educated at Haverford, Harvard, Göttingen and Leipzig, Richards became pro-

fessor of chemistry at Harvard (1901) and was awarded the Nobel prize for chemistry in 1914. From 1883 onwards he did much work on atomic weights, and considerably improved the technique of gravimetric determinations. Discovering in 1913, at the same time as Soddy, the isotopes of lead from uranium and thorium, he was associated with Wadsworth in the determination of the atomic weight of lead in minerals. He worked also on thermochemistry and thermodynamics.

Richardson, Sir Owen Willans

English physicist
 b. Apr. 26, 1879, Dewsbury, Yorks.
 Educated at Cambridge, Richardson became professor of physics at Princeton in 1906 and at King's College, London, in 1914. Famous for his work on the emission of electricity from hot bodies, he named this subject *thermionics*. He was elected F.R.S. in 1913 and was awarded the Nobel prize for physics for 1928. His most important publications are *The Electron Theory of Matter* (1914) and *The Emission of Electricity from Hot Bodies* (1916).

Richet, Charles Robert

French physiologist
 b. Aug. 26, 1850, Paris
 d. Dec. 4, 1935, Paris
 Educated in Paris, Richet became professor there (1887-1927). He was an authority on serum therapy and discovered anaphylaxis, a state of over-susceptibility to a second injection of a biologically foreign protein. He was awarded the Nobel prize for medicine in 1913, and published various technical and literary books.

Richter, Hieronymus Theodor

German chemist
 b. 1824, Dresden
 d. 1898, Freiberg
 A metallurgical chemist, Richter became director of the Freiberg School of Mines. With Reich in 1863 he discovered the element indium in zinc-blende by spectroscopic analysis, though he was only an assistant to Reich at the time.

RICHTER

Richter, Jeremias Benjamin
German chemist

b. Mar. 10, 1762, Schleswig

d. Apr. 14, 1807, Berlin

After studying under Kant at Königsberg, Richter was an assayer in Breslau and a chemist in a porcelain factory at Berlin. He treated chemistry as a branch of mathematics, an idea which often led him astray, but he made some notable contributions to the subject, discovering the law of equivalent proportions. Through his bad style some of his work was unappreciated at the time but Fischer did much to make his results generally known.

Rideal, Eric Keightley

English chemist

b. Apr. 11, 1890

Educated at Cambridge and Bonn, Rideal became professor of colloid science at Cambridge in 1930, in which year he was elected F.R.S., and was professor at the Royal Institution (1946-49). He has done important research upon colloids, catalysis and surface chemistry. With Walker he devised a standard test for measuring the germicidal power of a disinfectant against that of carboic acid on a typhoid broth culture. In 1950 he became professor of chemistry at King's College, London.

Riemann, Georg Friedrich Bernhard

German mathematician

b. Sept. 17, 1826, Breselenz, Hanover

d. July 20, 1866, Selasca, Lake Maggiore
After studying at Hanover, Lüneburg, Göttingen and Berlin, Riemann became professor at Göttingen (1857) but ill-health caused many interruptions in his career. A brilliant and original thinker, he is famous for a new non-Euclidean system of geometry named after him and described in his classic lecture *On the Hypotheses which form the foundation of geometry* (1854; pub. 1867). He deepened and developed the ideas of Bolyai and Lobachevsky (qq.v.), evolving conceptions of space capable of any number of dimensions described in terms of 'manifolds' and measurements of curvature. He introduced the idea of finite but unbounded space. He also did outstanding work on the

theory of functions of a complex variable, and on the potential theory.

Ritter, Johann Wilhelm

German physicist

b. Dec. 16, 1776, Samitz, Silesia

d. Jan 23, 1810, Munich

A Silesian scientist who worked in Jena and Munich, Ritter was the discoverer in 1802 in Jena of the ultra-violet rays in the spectrum (also discovered by Wollaston). In 1800 he succeeded in collecting oxygen and hydrogen separately by electrolysis, and in 1803 he discovered the principle of the accumulator.

Robert de Ketene or de Retines

English traveller and writer

c. 1143

There is considerable confusion about the life and exact dates of this early translator of foreign works, even his name being quoted in various ways. There seems to be little doubt however that he translated several scientific works from the Arabic into English, including a book on algebra and an early chemistry. These he intended to form part of an encyclopedia. He also was the first translator of the Koran and his use of Arab robes is said to have given rise to the university gown.

Roberts-Austin, Sir William Chandler

English metallurgist

b. Mar. 3, 1843, Kennington, London

d. Nov. 22, 1902, London

Professor of metallurgy at the Royal School of Mines, Roberts-Austin was Master of the Mint and an F.R.S. in 1875. He showed that diffusion can take place between a sheet of gold and a block of lead. He also designed an automatic recording pyrometer which employed a thermocouple for high temperature work, the instrument being used at the Royal Mint.

Roberval, Gilles Personne de

French mathematician

b. Aug. 8, 1602, Roberval, nr. Beauvais

d. Oct. 27, 1675, Paris

Professor of mathematics at the Collège de France in 1632, Roberval introduced

the *method of indivisibles* to deal with the quadrature of surfaces. He also discovered a general method of drawing tangents, and the Roberval balance was an invention of his.

Robinson, John Thomas Romney

Irish astronomer

b. Apr. 23, 1792, Dublin

d. Feb. 28, 1882, Armagh

Educated at Dublin, Robinson became professor of natural philosophy there, and later became astronomer at Armagh Observatory. There in 1846 he invented the cup anemometer, an instrument for measuring the velocity of the wind.

Robinson, Sir Robert

British chemist

b. Sept. 13, 1886, Chesterfield

Educated at Manchester, Robinson has held academic posts at Sydney, Liverpool, St. Andrews, Manchester, London and, since 1930, at Oxford. He was knighted in 1939. An F.R.S. and Copley medallist (1942), he became president of the Royal Society in 1945 and was awarded the Nobel prize for chemistry in 1947. One of the most brilliant of modern organic chemists, he is noted specially for his work on plant pigments, alkaloids and phenanthrene derivatives.

Robiquet, Pierre Jean

French chemist

b. Jan. 13, 1780, Rennes

d. Apr. 26, 1840, Paris

Robiquet is remembered as the discoverer of the codeine content of opium and, with Vauquelin, of asparagine.

Robison, Robert

English biochemist

b. 1883, Newark-on-Trent

Educated at Nottingham and Leipzig, Robison held various academic posts at Galway, Nottingham and the Lister Institute before going to London as professor of biochemistry. He has done much research work on phosphoric esters in metabolism and glucopyranose-6-monophosphate is known as the Robison ester.

Røemer, Olaus

Danish astronomer

b. Sept. 25, 1644, Aarhus, Jutland

d. Sept. 19, 1710, Copenhagen

A pupil of Bartholinus, Røemer became tutor to the Dauphin at Paris and eventually professor of astronomy at Copenhagen. He introduced micrometers and reading microscopes into observatories, and obtained the first trustworthy demonstration of the finite velocity of light by observations on the time of the eclipses of Jupiter's satellites in 1675 (22 mins. to cross the diam. of the earth's orbit). Among his remarkable precision instruments was the first practical transit instrument erected in 1690 in his house.

Rondelet, Guillaume

French naturalist

b. Sept. 27, 1507, Montpellier

d. July 30, 1566, Réalmont (Tarn)

Professor of medicine at Montpellier, and Chancellor for a time, Rondelet wrote a valuable work on aquatic animals in 1554-5, describing with illustrations about two hundred and fifty species.

Röntgen, Wilhelm Konrad

German physicist

b. Mar. 27, 1845, Lennep, Prussia

d. Feb. 10, 1923, Munich

After study in Holland and at Zürich, Röntgen became professor of physics at Strasbourg in 1876, in 1879 professor at Giessen, and in 1888 at Würzburg. Finally he went to Munich in 1900. He was awarded the Rumford medal in 1896 and the Nobel prize for physics in 1901. In 1895 he observed that crystals of barium platino-cyanide glowed brightly when near an exhausted tube through which an electric charge was passing, and that wrapped photographic plates were also affected. He traced the effect to rays coming from the walls of the tube on which the cathode rays were falling, and these rays he named X-rays. Their discovery inaugurated a new era in physics and medicine. He worked also on elasticity, heat conduction in crystals, specific heats of gases, and the electromagnetic rotation of polarised light.

ROOZEBOOM

Roozeboom, Hendrik Willem Bakhuis
Dutch physical chemist

b. Oct. 24, 1854, Alkmaar, Holland

d. Feb. 8, 1907, Amsterdam

Beginning as an industrial chemist, Roozeboom went to Leyden as assistant to Bemmelen and finally became professor of chemistry at Amsterdam. His fame rests upon his application of the phase rule, which had been deduced theoretically on thermodynamical grounds by Gibbs.

Roscoe, Sir Henry Enfield

English chemist

b. Jan. 7, 1833, London

d. Dec. 18, 1915, Leatherhead, Surrey

After studying at London under Graham and at Heidelberg under Bunsen, Roscoe worked with the latter in researches on quantitative photochemistry and evolved the law of reciprocity. With Bunsen in 1856 he invented the actinometer to measure the strength of the sun's actinic rays, in the course of a general investigation of the chemical action of light. He became professor of chemistry at Manchester in 1857, and made contributions to spectrum analysis. In 1869 he was the first to isolate metallic vanadium. He was an M.P. (1885-95) and Vice-Chancellor of London University (1896-1902).

Ross, Sir Ronald

British physician

b. May 13, 1857, Almora, India

d. Sept. 16, 1932, Putney Heath

From St. Bartholomew's Ross entered the Indian medical service and studied tropical diseases. He is famous for his demonstration of the life-history of the malarial parasite *Plasmodium* within the mosquito, and his proof that infection is transmitted by the bite of the female anopheline mosquito (1897-9). After holding several academic chairs Ross became director of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, in 1926. He was the Nobel prize winner for medicine in 1902.

Rossi, Bruno

Italian-American physicist

b. Apr. 13, 1905, Venice

Educated at Padua and Bologna, Rossi held posts at Florence, Padua and Manchester before becoming professor of physics at Cornell University in 1940. Noted for his work on cosmic rays, he published *Rayons Cosmiques* in 1935. He invented a circuit, named after him, for recording coincidences between Geiger-Müller counters which was a marked improvement on previous methods, and in 1933 was the first to measure absorption curves in lead and other materials. He showed that most cosmic rays are ionising, and identified the non-ionising few as photons. With Hilberry and Hoag he has conducted experiments on meson decay using the meson counter telescope.

Rouelle, Guillaume François

French chemist

b. 1703, Mathieu, nr. Caen

d. Aug. 3, 1770, Passy, nr. Paris

Assistant at the Jardin du roi, Paris, in 1744 Rouelle was the first to distinguish between neutral, acid and basic salts. A popular and influential teacher, he had as one of his pupils Lavoisier.

Roux, Pierre Paul Émile

French bacteriologist

b. Dec. 17, 1853, Confolens, Charente

d. Nov. 3, 1933, Paris

Trained in medicine, Roux worked at the Faculty of Medicine in Paris and then at the Pasteur Institute, of which he became director in 1904. His work there must be regarded as one of the corner-stones of modern serum therapeutics. He worked with Yersin on diphtheria, demonstrating the diphtheria bacillus toxin, thus facilitating the preparation of an anti-toxin (by Behring). He was associated with Pasteur in his work on anthrax, hydrophobia and tetanus. With Mechnikov he prepared the first successful syphilis vaccination and worked also on cholera and tuberculosis. See also E. I. E. Nocard.

Roux, Wilhelm

German zoologist

b. June 9, 1850, Jena

d. Sept. 15, 1924, Halle

A pupil of Haeckel, Roux was professor of

anatomy at Innsbruck (1889) and Halle (1895), and was an expert on developmental physiology. He was the first to emphasise the importance of functional differentiation, that is, changes in organs and tissues due to use or disuse. He made important contributions also to experimental embryology by his studies of the development of fertilised eggs.

Rowland, Henry Augustus

American physicist

b. Nov. 27, 1848, Homesdale, Pa.

d. Apr. 16, 1901, Baltimore

Assistant professor of physics at Troy, and, from 1875, first professor of physics at the Johns Hopkins University, Rowland was the first to succeed in ruling fine gratings on concave speculum metal mirrors to obtain a normal solar spectrum, that is one in which equal distances correspond exactly to equal increments of wavelength. This grating is named after him. He proved that a charged body in motion produces a magnetic field similar to that of an electric current. In 1879 he repeated Joule's work on the mechanical equivalent of heat, making corrections in details which had been proved to be faulty, and he demonstrated that the specific heat of water is not constant from 0 to 100°C. as Joule had assumed.

Rubens, Heinrich

German physicist

b. Mar. 30, 1865, Wiesbaden

d. Feb. 17, 1922, Berlin

Professor in Berlin and an early experimenter in spectroscopy, Rubens worked on infra-red rays of great length in connection with their penetration of paraffin, benzine, etc. He evolved a method of isolating residual waves (Reststrahlen) by repeated reflections from selected minerals.

Rücker, Sir Arthur William

English physicist

b. Oct. 23, 1848, Clapham, London

d. Nov. 1, 1915, Newbury, Berks.

Educated at Oxford, Rucker became professor of mathematics and physics at Leeds in 1874 and at the Royal College of Science in 1886. He carried out a

magnetic survey of the British Isles with Thorpe, and with Professor Reinold used Jamin's interferometer to measure the thickness of a soap film (Properties of Liquid Films, papers 1880-92).

Rudbeck, Olof

Swedish scientist

b. 1630

d. 1702

Noted for his discovery of the lymphatic system, Rudbeck has also given his name to the genus of plants *Rudbeckia*. He published *Atlantika* (1675-98) in which he endeavoured to show that Plato's Atlantis was situated in Sweden.

Rudolf, Christoff

German mathematician

c. 1500

In 1525 Rudolf published a book on algebra in which he introduced the radical sign $\sqrt{\quad}$ for square root.

Ruhmkorff, Heinrich Daniel

German instrument maker

b. Jan. 15, 1803, Hanover

d. Dec. 20, 1877, Paris

Living in Paris, in 1851 Ruhmkorff constructed the famous induction coil named after him and based on Faraday's experiments. This was shown in the Paris Exhibition of 1855. His workshop, opened in 1840, became the firm of Carpentier.

Rumford, Sir Benjamin Thompson, Count

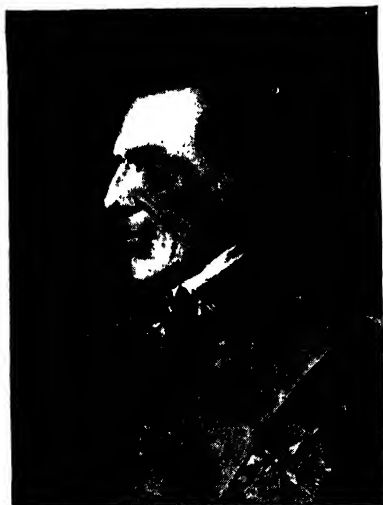
British physicist and administrator

b. Mar. 26, 1753, Woburn, Mass.

d. Aug. 21, 1814, Auteuil, nr. Paris

Forced to quit America on account of his loyalist sympathies, Rumford entered the service of the Elector of Bavaria in 1784 and became Minister of War and Police. His administrative efficiency earned him a Countship of the Holy Roman Empire. He was married twice, his second wife being Lavoisier's widow from whom he later separated. In 1799, back in England, he founded the Royal Institution, and later the Bavarian Academy at Munich. From 1802 he lived mostly in France. He invented a simple photometer to com-

RUMSEY



COUNT RUMFORD

pare the strength of light sources by the shadows of a cylindrical object on a screen, but he is chiefly noted for his researches in heat. The caloric notion of heat received its dismissal when he noticed that the metal chips from the boring of a cannon were exceedingly hot. With these he boiled water and demonstrated to his sceptical fellow scientists that heat is a form of energy or, as he phrased it, motion. He was responsible also for improvements in cooking and heating systems and in animal breeding. He endowed the Rumford medals.

Rumsey, James

American inventor

b. 1743, Bohemia Manor, Maryland

d. Dec. 23, 1792, London

A mechanical engineer by profession, Rumsey was one of the earliest, if not actually the first, to construct a steamboat. It is interesting to note that his first idea was 'jet propulsion', water being drawn into the boat and ejected at the stern. The first trial was dated Dec. 3rd, 1787. Rumsey later came to England and tried a steamboat on the Thames, but in the same year, 1792, he died suddenly before achieving his second version.

Runge, Carl David Tolmé

German mathematician and physicist

b. Aug. 30, 1856, Bremen

d. Jan. 3, 1927, Göttingen

Educated at Munich and Berlin, Runge became professor of mathematics at Hanover and later at Göttingen. He did notable work on the theory of functions, differential equations, and other topics, and in physics he investigated magnetic resolution in spectroscopy.

Runge, Friedlieb Ferdinand

German chemist

b. Feb. 8, 1795, nr. Hamburg

d. Mar. 25, 1867, Oranienburg

Professor of chemistry at Breslau, in 1834 Runge discovered carbolic acid in coal tar. In the same substance he discovered aniline (1834), and he investigated dry distillation and the composition of matter.

Russell, Bertrand Arthur William, 3rd Earl Russell

English mathematician and philosopher

b. May 18, 1872, Trelleck, Mon.

Educated first privately and then at Cambridge, Bertrand Russell has contributed enormously to philosophy and the philosophical aspects of mathematics. In his *Principia Mathematica* (1910-13), with Whitehead, he develops the idea of the unity of mathematics and formal logic. His philosophical principles have brought him into conflict with accepted religious beliefs, and also with the civil authorities during the first world war when his pacifism cost him his fellowship of Trinity College, Cambridge. He is undoubtedly one of the foremost thinkers of the age, and has evolved a philosophical scepticism based on logical analysis. He wrote, among many other works, *The Principles of Mathematics* (1903, 1937), *The Problems of Philosophy* (1912), *Introduction to Mathematical Philosophy* (1919), *Analysis of Matter* (1927), *Power: A New Social Analysis* (1938), *A History of Western Philosophy and Physics and Experience* (1946).

Russell, Henry Norris

American astronomer

b. Oct. 25, 1877, Oyster Bay, N.Y.

Educated at Princeton and Cambridge, Russell became professor of astronomy at Princeton (1900) and research associate at Mt. Wilson (1921). He is known for his work on astrophysics and stellar origins. In 1913 he was awarded the Gold Medal of the Astronomical Society for his newly-developed theory of giant and dwarf stars (independently of Hertzsprung). This was embodied in his *Probable Order of Stellar Evolution* (1914) and was for a time widely accepted. Later theoretical work (c.1923) showed it to be unsatisfactory.

Rutherford, Daniel

Scottish physician and chemist

b. Nov. 3, 1749, Edinburgh

d. Nov. 15, 1819, Edinburgh

The uncle of Sir Walter Scott, Rutherford was educated at Edinburgh in medicine and became professor of botany there in 1786. From a suggestion by Joseph Black he conducted an investigation on air and so discovered what he called 'noxious air' (nitrogen). He was the first to distinguish clearly between carbon dioxide and nitrogen. He invented also a maximum and minimum thermometer.

Rutherford, Ernest, Lord

British physicist

b. Aug. 30, 1871, Nelson, New Zealand

d. Oct. 19, 1937, Cambridge

Educated at New Zealand University and at Trinity College, Cambridge, Rutherford worked in the Cavendish laboratory under J. J. Thomson (1895) on electromagnetic waves. In 1898 he became professor of physics at McGill University, where he worked on radioactivity. He came to Manchester in 1907 and was Cavendish professor of physics at Cambridge in 1919 in succession to J. J. Thomson. He was awarded the Nobel prize for chemistry in 1908, having been elected F.R.S. in 1903. He was created Baron Rutherford of Nelson in 1931. He discovered and named alpha, beta and gamma rays emitted from radioactive salts and studied radioactive transformations. With Soddy in 1902 he predicted that some radioactive elements should generate helium, and suggested its accumulation as a



ERNEST RUTHERFORD, the most important single figure in the history of atomic studies.

method of measuring the age of the rocks. He also suggested measuring the amount of the end-product lead for the same reason. He created artificial pleochroic haloes in glass and in flakes of biotite. In 1911 he suggested the divisible nuclear atom, (the Rutherford atom), that is a small positive nucleus and outer electrons. He disintegrated the hydrogen nucleus with radium alpha-particles, and was thus the first to effect the transmutation of an element. This opened the way to atomic energy. Among his works are *Radioactivity* (1904), *Radioactive Transformations* (1906) and *Radioactive Substances and their Radiations* (1912). See the Life by A. S. Eve.

Ružička, Leopold W. G.

Swiss chemist

b. Sept. 13, 1887, Vukovar, Yugoslavia

Professor of chemistry at Utrecht (1926) and then at Zürich (1929), Ružička was the first to synthesise musk. He did distinguished work on polymethylenes and higher terpenes (sesquiterpenes), and on organic synthesis generally. His investiga-

RYDBERG

tions of the chemical structure of the sterols resulted in his synthesis, by degradation from the neutral cholesterol, of the male sex hormones androsterone and the more active testosterone, used in male functional disorders (1934-35). For this work, the first synthesis of sex hormones, he shared the Nobel prize for chemistry with Butenandt in 1939. His method of using a sterol of suitable ring structure as a basis, after the removal of the side-chain, provided a solution to hormone production.

395

Rydberg, Johannes Robert

Swedish physicist

b. Nov. 8, 1854, Halmstad

d. Dec. 28, 1919, Lund

Professor of physics at Lund, Rydberg developed in 1890, independently of Balmer, a well-known formula for series of spectral lines.

$$\nu = R \left[\frac{1}{(n+a)^2} - \frac{1}{(m+b)^2} \right]$$

where R is Rydberg's constant ($R_H = 109677.6 \text{ cm}^{-1}$).

396

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Sabatier, Paul

French chemist

b. Nov. 5, 1854, Carcassonne, Aude

d. Aug. 16, 1941, Vichy

Educated at the École Normale, Sabatier was professor of chemistry at Nîmes, Bordeaux and finally in 1882 at Toulouse. In 1912 he shared with Grignard the Nobel prize for chemistry. An expert on catalysis, he is famous as the co-discoverer (with Senderens) of the process for the catalytic hydrogenation of oils to solid fats. Margarine is made by this method from vegetable and fish oils. He is the author of *La catalyse en chimie organique* (1913).

Sabine, Sir Edward

English soldier, physicist and astronomer

b. Oct. 14, 1788, Dublin

d. June 26, 1883, Richmond, Surrey

Educated for the army, Sabine served many years as a soldier before settling down to scientific pursuits. He was elected F.R.S. in 1818 and in 1861 became president of the Society for ten years. He was astronomer to the North West Passage expeditions (1818, 1819-20). Sabine did much work on the figure of the earth and on terrestrial magnetism, in which latter connection he was in charge of the chain of observatories set up to study the subject. The result was a complete magnetic survey of the world and the discovery of a connection between sunspots and terrestrial magnetic disturbances.

Sachs, Julius von

German botanist

b. Oct. 2, 1832, Breslau

d. May 29, 1897, Würzburg

A pupil of Purkinje, Sachs became professor of botany at Würzburg. Famous for his work on nutrition, he studied the connection between sunlight and chlorophyll. He showed that the chlorophyll is

contained in special bodies (named *chloroplasts* by Schimper) and not generally diffused in tissues. He worked on heliotropism and geotropism, and introduced the *clinostat* for this purpose. In 1865 he produced his important work on botanical physiology *Handbuch der Experimentalphysiologie der Pflanzen*. See E. C. Pringsheim, *Julius Sachs* (1932).

Sanctorius, Sanctorius (or Santorio, Santorio)

Italian physician

b. 1561, Capo d'Istria

d. Feb. 24, 1636, Venice

A professor of Padua, Sanctorius is remembered for his invention of the clinical thermometer. He invented also a pulse clock which, however, as it did not gain recognition, Floyer re-invented a century later. Sanctorius is especially famous for his experiments on metabolism, in which he spent a considerable part of his life on a balance of his own devising, measuring what he called 'insensible perspiration,' that is, small changes in weight during various functions, such as eating and sleeping.

Saussure, Horace Bénédict de

Swiss physicist and geologist

b. Feb. 17, 1740, Geneva

d. Jan. 22, 1799, Geneva

The professor of physics and philosophy at Geneva, Saussure introduced the word *geology* into scientific nomenclature, and the mineral *saussurite* is named after him. He is regarded as the founder of modern mountaineering as in 1787 he was the first traveller to ascend Mt. Blanc. The summit had previously been reached by guides. He also devised the hair hygrometer.

Savart, Félix

French physicist

b. June 30, 1791, Mézières, Ardennes

d. Mar. 16, 1841, Paris

SAYERS

After training and practising as a physician Savart taught physics in Paris. With Biot he discovered the law named after them relating to the force in a magnetic field round a long straight current. He devised *Savart's wheel* to measure tonal vibrations and the Savart quartz plate for investigating polarisation of light.

Sayers, J.
British physicist
b. 1913

Educated at Belfast, Birmingham and Cambridge, Sayers became professor of electron physics at Birmingham University. He was one of the British team who took part in the atomic bomb project, and he gained a government award of £12,000 in 1949 for his share in the development of the cavity magnetron valve (1940) which proved of such immense value in the development of radar.

Scaliger, Joseph Justus
French scholar
b. Aug. 5, 1540, Agen, Garonne
d. Jan. 21, 1609, Leyden

After studying languages at Paris, Scaliger became professor at the Geneva Academy for a time and then, after twenty years in France, became professor at Leyden. In 1582 he devised the first completely scientific system of time, the Julian Period, a cycle of 7980 years ($29 \times 19 \times 15$) starting from Jan. 1st. 4713 B.C. (Not to be confused with the Julian Calendar.) He is remembered mainly perhaps as the most famous scholar of any age, attaining a pre-eminence of power unrivalled by any literary figure before or since. His study of ancient chronology put that department on a new footing and prepared the way for a modern chronology.

Schaudinn, Fritz Richard
German zoologist
b. Sept. 19, 1871, Röseningken
d. June 22, 1906, Hamburg

The director of the department of protozoological research, Institute for Tropical Diseases, Hamburg, with Hoffmann in 1905 he discovered the *Spirochaeta pallida* which causes syphilis. He demonstrated

the amoebic nature of tropical dysentery, and worked on trypanosomes and other organisms. He also discovered the alternation of generations in Foraminifera and Coccidiae.

Scheele, Karl Wilhelm
Swedish chemist

b. Dec. 19, 1742, Stralsund, Pomerania
d. May 19, 1786, Köping, Västmanland
Apprenticed to an apothecary, with whom he studied chemistry, Scheele practised as a chemist at Malmö, Stockholm, Uppsala and Köping. Though never in good circumstances, he was able to make important chemical discoveries as a result of his lifelong devotion to his subject. His experiments on air and combustion led to his discovery of oxygen, but delay in publication (1777) was the cause of Priestley's results appearing first (*see also* J. Mayow). He made other important discoveries, such as the production of phosphorus from bone ash, the action of light on silver salts, and the synthesis of many organic acids such as tartaric, oxalic, lactic, uric, prussic, hydrofluoric, benzoic, arsenious, molybdic, citric, malic, gallic, and others. He also discovered chlorine in 1774 and glycerine in 1779, Scheele's green (copper arsenite), baryta and methane.

Schiaparelli, Giovanni Virginio
Italian astronomer
b. Mar. 14, 1835, Savigliano, Piedmont
d. July 4, 1910, Milan

Educated at Turin in mathematics and engineering, Schiaparelli turned to astronomy and trained under Struve at Pulkova. He became director of the Brera Observatory in Milan. Among his famous discoveries were the connection between comets and meteorites, and the 'canals' of Mars (1877) and the asteroid Hesperia (1861). He became almost totally blind in late life.

Schimper, Andreas Franz Wilhelm
German botanist
b. May 12, 1856, Strasbourg
d. Sept. 9, 1901, Basle

One of the first to prepare a map of plant

distribution, his *Pflanzengeographie* (1898) is one of the best produced. This comparatively recent line of study has brought out some unlooked-for results, such as the extraordinary stability of plant territories and the apparent difficulty with which even the most fertile plants spread to new areas. Schimper introduced the term *chloroplast* to biological terminology, and differentiated it from chromatophore. His father, Wilhelm Philipp (1808-1880), was an expert on mosses, and his father's cousin, Karl Friedrich (1803-67), made important studies in plant morphology.

Schmidt, Bernhard

German astronomer

b. 1879, Nargen, Estonia

d. 1935

Schmidt, who was of Swedish-German parentage, studied optics in Sweden before settling near Jena for 25 years. An unambitious man of simple tastes, he made a bare living by grinding reflectors for telescopes. This he did with his left hand, as his right had been lost in early youth. In 1926 he was persuaded to abandon his retreat and to become a 'voluntary associate' of the Hamburg Observatory in Bergedorf. In 1932 Schmidt announced his new method for dealing with spherical aberration in astronomical telescopes and cameras. He suggested the introduction of a plate incorporating the necessary corrections at the centre of curvature of the mirror. This has the effect of producing a large angular field, though as a result of the curvature of the image the photographs have to be taken on curved films. Baker and Hendrix in America applied Schmidt's discovery in the construction of the Palomar Schmidt telescope, used as a pilot to the 200 inch reflector.

Schmidt, Johannes

Danish biologist

b. 1877, Jägerspris, Spoelland

d. Feb. 22, 1933, Copenhagen

Following on Grassi's work, Schmidt made the important discovery (1904) that the breeding ground of the European eel is a small area on the ocean bed SE. of

Besmuda. This problem had long baffled students of migration, and it is thought that this area was originally a lake in a now submerged continent and that the eels have merely maintained a tradition through a series of major geographical alterations. Schmidt was for many years director of the Carlsberg Physiological Laboratory, and made many important contributions to oceanography and biology.

Schmidt, Johann Friedrich Julius

German astronomer

b. Oct. 26, 1825, Eutin

d. Feb. 7, 1884, Athens

After working at Altona, Bilk and Bonn observatories, Schmidt went in 1858 to Athens as the director of the national observatory there. He was an eminent selenographer and the first to suggest that some slight changes are still taking place on the moon's surface, for example in the crater Linné. He worked also on comets, variable stars, zodiacal light, and was the author of several books and a map of the moon (1878, 25 sheets).

Schönbein, Christian Friedrich

German chemist

b. Oct. 18, 1799, Metzingen, Swabia

d. Aug. 29, 1868, Sautersberg, nr. Baden-Baden

Educated at Tübingen and Erlangen Schönbein finally became professor of chemistry and physics at Basle in 1828. He is noted as the discoverer of ozone in 1840, and he worked also on hydrogen peroxide and gun-cotton. In 1846 he used the latter in firearms and from it prepared, for the first time, collodion.

Schrödinger, Erwin

Austrian physicist

b. Aug. 12, 1887, Vienna

Educated at Vienna, Schrödinger became professor at Stuttgart, Breslau, Zürich, Oxford, Graz and Berlin, and in 1940 became professor at the Dublin Institute for Advanced Studies. He shared with Dirac the Nobel prize for physics in 1933, and is especially famous for his work on wave-mechanics, recorded in *Collected Papers on Wave-Mechanics* (1928). He

SCHÜTZENBERGER

evolved a theory of the atom based on wave mechanics, and in 1946 began work on a new field theory. He wrote also *Four Lectures on Wave Mechanics* (1928), *Statistical Thermodynamics* (1945) and *What is Life?* (1946).

Schützenberger, Paul

French chemist

b. Dec. 23, 1829, Strasbourg

d. June 26, 1897, Mézy, Seine-et-Oise

Noted for his researches in physiological chemistry, Schützenberger worked also on dyes and fermentation. He wrote several text-books including *Traité de Chimie Générale* (1879-94). He was a professor in Mülhausen, and from 1876 at the Collège de France.

Schwabe, Heinrich Samuel

German astronomer

b. Oct. 25, 1789, Dessau, Anhalt

d. Apr. 11, 1875, Dessau

Educated at Berlin, in 1826 Schwabe began a systematic daily survey of the sun's surface which led to his discovery of a ten year sun-spot cycle (1843); the period was later shown to be rather more than eleven years.



GLENN THEODORE SEABORG has contributed to the discovery of five new elements.

Schwann, Theodor

German physiologist

b. Dec. 7, 1810, Neuss, Prussia

d. Jan. 11, 1882, Cologne

After studying at Cologne, Bonn and Würzburg, and under Johannes Müller, Schwann became professor of anatomy at Louvain and then at Liège. He was one of the greatest investigators of cell structure and the relation between cell and organism. His recognition (1838) of the ovum as a cell was epoch-making, and he went on to state three conclusions: (1) the entire plant or animal consists of cells or substances thrown off by cells. (2) The cells have a certain amount of individual life. (3) The life of the cell is subject to that of the organism as a whole. These conclusions, which are still accepted, were published in his *Microscopic Investigations on the Accordance in the Structure and Growth of Plants and Animals* (1839), which may be regarded as the foundation of the cell theory. He discovered pepsin, and investigated digestion, nerve signals and muscle contraction.

Schweigger, Johann Salomo Christoph

German physicist

b. Apr. 8, 1779, Erlangen

d. Sep. 6, 1857, Halle

Professor successively at Bayreuth, Nürnberg, Erlangen and Halle (1819), Schweigger worked on electrical measurement and electromagnetism. In 1820 he invented the string galvanometer. He founded the *Jahrbuch für Chemie und Physik* (1821).

Seaborg, Glenn Theodore

American physical chemist

b. Apr. 19, 1912, Ishpeming, Mich.

Professor of chemistry at California (1945), Seaborg is known for his researches on the transuranic elements, of which he helped to discover plutonium, americium and curium, and for work on the actinide series. In 1950 he and his associates produced berkelium (97) and californium (98) by alpha bombardment of americium and curium. With McMillan he was awarded the Nobel prize for chemistry in 1951 for this work.

Secchi, Angelo

Italian astronomer

b. June 29, 1818, Reggio, Lombardy*d.* Feb. 26, 1878, Rome

Educated as a Jesuit priest, after a period of teaching in America Secchi returned to become head of the observatory at the Collegio Romano. He is noted as the originator of the spectroscopic survey of the heavens, and for making the first classification of the stars according to their spectral types.

Sedgwick, Adam

English geologist

b. Mar. 22, 1785, Dent*d.* Jan. 27, 1873, Cambridge

Educated at Trinity College, Cambridge, Sedgwick became in 1818 professor of geology there. He did pioneer work in 1822 on the Lake District. He named the Cambrian System and, with Murchison, established the Devonian System.

Seebeck, Thomas Johann

German physicist

b. 1770, Reval*d.* 1831, Berlin

After being associated with Goethe in the production of the latter's well known theory of colour, Seebeck investigated thermo-electricity and invented the thermocouple, his original circuit being made of copper and bismuth.

Seeliger, Hugo

German astronomer

b. Sep. 23, 1849, Bielitz-Biala*d.* Dec. 2, 1924, Munich

Educated at Heidelberg and Leipzig, after being assistant at the Bonn Observatory Seeliger became director of the observatory at Gotha and then professor of astronomy at Munich and director of that observatory. He is famous for his work on star distribution and for his star and nebula theory for the birth of a nova.

Sefström, Nils Gabriel

Swedish physician and chemist

b. 1787, Ilsbo Socken*d.* 1854

After studying medicine, Sefström became

professor of chemistry and science at the Caroline Institute of Medicine and Surgery. In 1831 he discovered the element vanadium in a specimen of soft iron. This had already been discovered by Del Rio in 1801, who however had doubts about it and thought it might be chromium.

Senderens, Jean Baptiste

French chemist

b. 1856, Barbachen, Hautes-Pyrénées*d.* Sep. 26, 1937

An authority on catalysis, Senderens was associated with Sabatier in the discovery of the hydrogenation of oils by catalysis in 1899.

Senebier, Jean

Swiss pastor

b. May 6, 1742, Geneva*d.* July 22, 1809, Geneva

A librarian in Geneva, in 1782 Senebier showed that green plants under the influence of light convert 'fixed air' (carbon dioxide) into 'dephlogisticated air' (oxygen).

Sertürner, Friedrich Wilhelm Adam

German chemist

b. June 19, 1783, Neuhaus, nr. Paderborn*d.* Feb. 20, 1841, Hameln

An apothecary's assistant at Paderborn, in 1805, by isolating morphine, which he discovered, from opium, Sertürner proved the existence of organic bases containing nitrogen.

Servetus, Michael

Spanish theologian and physician

b. Sept. 29, 1511, Tudela, Navarre*d.* Oct. 27, 1553, Geneva

After studying law at Toulouse, Servetus turned to medicine. He discovered the pulmonary circulation and the purification of the blood by the lungs, and taught geometry and astrology. He denied the Trinity, escaped the Inquisition, but was condemned for heresy by Calvin and burned at the stake with his books.

Shanks, W.

English mathematician

c. 1870

SHAPLEY

In 1873 Shanks calculated π to 707 decimal places. He computed numerous other constants, including e , modulus M , and Euler's constant (to 201 places in 1872).

Shapley, Harlow

American astrophysicist

b. Nov. 2, 1885, Nashville, Tenn.

Educated at Missouri and Princeton, Shapley went to Mt. Wilson for seven years in 1914 and then became professor of astronomy at Harvard and director of the observatory. One of the most famous contemporary astronomers, he includes among his brilliant researches a theory to explain Cepheid variables, an estimate of the size of the universe and a description of its form of construction. He has done notable work on photometry and spectroscopy, and is a distinguished teacher.

Shaw, Sir William Napier

English meteorologist

b. Mar. 4, 1854, Birmingham

d. Mar. 23, 1945

Educated at Cambridge, Shaw became Director of the Meteorological Office (1905)



HARLOW SHAPLEY testifies before a Senate sub-committee on atomic secrets.

and professor at the Royal College of Science (1920). He wrote a famous treatise with Lempfert on the *Life-History of Surface Air Currents*, and measured the rate of descent of the air in two anticyclones as 350 and 450 metres per day. He calculated that in the case of one particular depression, two million million tons of air must have been removed to account for the fall in pressure.

Sherman, Henry Clapp

American biochemist

b. Oct. 16, 1875, Ash Grove, Virginia

Educated at Maryland and Columbia, Sherman became professor of organic chemistry (1907), of nutritional chemistry (1911) and of chemistry (1924) at the latter university. He has done important work on vitamins and is noted for his quantitative work in this field. In 1911 he published *Chemistry of Food and Nutrition*, and in 1922 *The Vitamins* (with S. L. Smith).

Sherrington, Sir Charles Scott

English physiologist

b. Nov. 7, 1861; d. Mar. 5, 1952

Educated at Cambridge, an F.R.S., and professor successively at Liverpool (1895), London (1914) and Oxford (till 1936), Sherrington was a leading authority on the nervous system. He was president of the Royal Society from 1920 to 1926 and became a member of the Order of Merit in 1924. With Adrian he was awarded the Nobel prize for medicine in 1932 for their work on the neuron and its function. His other physiological researches include work on decerebrate rigidity, the reflex system, and the renewal of nerve tissue. He made a study of school hygiene and was joint author of *School Hygiene* (1913). He wrote many papers on the brain and related subjects, and among his books are *The Integrative Action of the Nervous System* (1906, 1947) and *Man on his Nature* (1940).

Sidgwick, Nevil Vincent

English chemist

b. May 8, 1873; d. Mar. 15, 1952

Sidgwick was a professor at Oxford (1935-

45) and is known for his work on molecular structure and his formulation of a theory of valency (*The Electronic Theory of Valency*, 1927).

Siegbahn, Karl Manne Georg

Swedish physicist

b. Dec. 3, 1886, Örebro

Educated at Lund, Siegbahn became professor there (1920), at Uppsala (1923) and Stockholm (1937). He is an authority on X-ray spectroscopy and was the discoverer of the M series in this spectrum. He was awarded the Nobel prize for physics for 1924, and published *Spektroskopie der Röntgenstrahlen* in 1931. He devised a vacuum spectrograph.

Siemens, Sir William (Karl Wilhelm)

British engineer

b. Apr. 4, 1823, Lenthe, Hanover

d. Nov. 19, 1883, London

Settling in England in 1843 because of the superior patent laws which this country enjoys, Siemens became an F.R.S. in 1862 and president of the British Association in 1882. He patented his differential governor in 1844, and was the first to attempt to make a platinum resistance thermometer, which however was not a success owing to the use of a fireclay cylinder as a former for the wire. He invented the bathometer, an instrument for measuring the depth of water beneath a vessel, depending on the reduced value of 'g' resulting from the water underneath. He was the first to apply the electric arc to fusion in 1879, and in connection with this he developed a satisfactory process for cremation. He invented the dynamometer named after him for measuring power in A.C. circuits, and a regenerative furnace for the manufacture of steel which has largely replaced the Bessemer process. He was responsible for one of the earliest electric tramways (at Portrush, opened 1883). He was English manager of the firm Siemens Brothers founded at Berlin (1847) by his brother Ernst Werner von Siemens (1816-92), an engineer and electrician who developed telegraphy and the self-acting dynamo and gave his name to the Siemens unit.

Simpson, Sir George Clarke

English meteorologist

b. 1878, Derby

Educated at Manchester and Göttingen. Simpson became lecturer on meteorology at Manchester in 1905. He later held many appointments connected with meteorology and was president of the Royal Meteorological Society from 1940 to 1942. He was meteorologist with Scott on his Antarctic expedition. He has investigated the causes of lightning and suggests that the high electrical charge in the lower parts of clouds is caused by the breaking up of raindrops.

Simpson, Sir James Young

Scottish physician

b. June 7, 1811, Bathgate, West Lothian

d. May 6, 1870, London

Educated at Edinburgh, Simpson became professor of midwifery there in 1840. He was first to use ether as an anaesthetic in childbirth (Jan. 19, 1847) but is most famous for his discovery of the anaesthetic properties of chloroform (Nov. 4, 1847) and its introduction into general use. He later devoted himself to hospital reform and became one of Queen Victoria's physicians. See B. Duncan, *Development of Inhalation Anaesthesia* (1947).

Simpson, Thomas

English mathematician

b. Aug. 20, 1710, Market Bosworth, Leicestershire

d. May 14, 1761, Market Bosworth

A weaver, Simpson educated himself and became an usher at a school. By unremitting effort he became so proficient in mathematics as to be appointed professor of mathematics at Woolwich (1743) and an F.R.S. (1746). He wrote many well-known books on the subject (e.g. *A New Treatise on Fluxions*, 1737) and was the inventor of the rule, named after him, for finding the area of a figure given only a limited number of data.

Sitter, Willem de

Dutch astronomer

b. May 6, 1872, Sneek

d. Nov. 20, 1934, Leyden

ŠKODA

Educated at Groningen under Kapteyn, in 1908 Sitter became director of the Leyden Observatory and professor of astronomy there. He was 'perhaps the greatest expert of his time on the application of Einstein's theory to the problems of the universe. He has computed the size of the universe as two thousand million light years in radius, containing about 80,000 million galaxies. His idea of the universe is an expanding space-time continuum with motion and no matter (dynamic), as opposed to Einstein's of one with matter and no motion (static).

Škoda, Joseph

Czech physician

b. Dec. 10, 1805, Pilsen

d. June 13, 1881, Vienna

Škoda studied in Vienna, where he rapidly acquired a considerable reputation, becoming in 1846 clinical professor at the hospital for diseases of the chest. His *Abhandlung über Auskultation und Perkussion* (1839), modifying and completing the work of Laënnec, firmly established modern diagnostic practice.

Slipher, Vesto Melvin

American astronomer

b. Nov. 11, 1875, Clinton County, Ind.

Educated at Indiana, Slipher went to the Lowell Observatory in 1901. He is well known for his spectroscopic researches on the four major planets in which he finally settled the question of the rotation period of Uranus. He also proved the presence of water vapour in the Martian atmosphere by photographs in the infra-red spectrum, but his most famous contribution to astronomy is his measurement of the rotation and velocity of spiral nebulae and the discovery that some nebulae shine by reflected light, for example the Pleiades.

Smith, Sir Francis Pettit

English inventor

b. Feb. 9, 1808, Hythe, Kent

d. Feb. 12, 1874, South Kensington

A farmer at first, Smith soon became interested in working models and in 1835 made a model of a screw-propelled boat.

He patented his idea in 1836 and though there are hundreds of claimants for the credit, he and Ericsson (who patented his six weeks later) must share the honour of building the first successful ships so driven. Smith's first boat was the *Francis Smith* (1836), a six-ton vessel, and it originally had a wooden screw. He built the Royal Navy's first screw steamship (1839) and the first screw warship, the *Rattler* (1841-43).

Smith, Henry John Stephen

English mathematician

b. Nov. 2, 1826, Dublin

d. Feb. 9, 1883, Oxford

Educated at Oxford, Smith became Savilian professor of geometry in 1861 and was elected F.R.S. in the same year. He did notable work on the theory of numbers and elliptic functions, his work on the former topic being particularly significant.

Smith, William

English geologist

b. Mar. 23, 1769, Churchill, Oxfordshire

d. Aug. 28, 1839, Northampton

Known as the father of English geology, Smith started as a land surveyor, thus having the opportunity to examine the limestones and clays of the Cotswolds. He emerged from obscurity with a *Geological Map of England and Wales* (1815). He was the first to prove that fossils dated rocks, and in 1816 produced his *Strata Identified by Organised Fossils*, thus inaugurating stratigraphical geology. He became involved in financial difficulties and was obliged to sell his collection of fossils to the British Museum, but was later granted a government pension. He received the first Wollaston medal (1831) and was an expert on land drainage and irrigation.

Snell, Willebrod van Roijen (Lat. Snellius)

Dutch mathematician

b. 1591, Leyden

d. Oct. 30, 1626, Leyden

An infant prodigy, at the age of twelve Snell was fully acquainted with all the standard mathematical works. In 1613 he

succeeded his father as professor of mathematics at Leyden and discovered the law named after him, which states that when a ray of light passes from one medium to another the sine of the angle of incidence divided by the sine of the angle of refraction is constant. This constant is the refractive index. In 1617 he conceived the idea of measuring the size of the earth by triangulation, the first step towards a real knowledge of the subject though, owing to faulty instruments, his results were inaccurate.

Sobrero, Ascanio

Italian chemist

b. 1812

d. 1888

Professor of chemistry at the Institute of Technology, Turin, in 1847 Sobrero discovered nitro-glycerine by the action of nitric acid on glycerine

Soddy, Frederick

English physicist and chemist

b. Sept. 2, 1877, Eastbourne

Trained under Rutherford at McGill and then Ramsay at London, Soddy became in 1914 professor of chemistry at Aberdeen, and in 1919 at Oxford. He gained the 1921 Nobel prize for chemistry, having been elected F.R.S. in 1910. He retired from his Oxford chair in 1936. In 1902 with Rutherford he predicted the formation of helium by some radioactive elements. In the same year Rutherford and he announced a simple law of atomic disintegration: 'The probability of an atom breaking up is independent of its age.' In 1904 with Ramsay he discovered the spontaneous transformation of radium emanation into helium, and he gave the name *isotopes* to the different varieties of lead which he (and Richards independently) discovered in 1913 in radioactive minerals. It was his discovery of and work on isotopes which earned him his Nobel prize. He was the author of many books on atomic physics and finance, e.g. *The Interpretation of Radium* (1909), *Matter and Energy* (1912), *The Interpretation of the Atom* (1932).

Solvay, Ernest

Belgian chemist

b. Apr. 16, 1838, Rebecq, Brussels

d. May 26, 1922, Brussels

An industrial chemist, Solvay succeeded (1863) in devising a process, named after him, for the production of sodium carbonate. This has now replaced the Leblanc process, especially under the improvements introduced at the Imperial Chemical works (see Mond).

Sommerfeld, Arnold

German physicist

b. 1868, Königsberg; d. 1951

Sommerfeld became professor of mathematics at Clausthal (1897), of physics at Aachen (1900) and at Munich (1906). His first work was on the theory of the gyroscope (with Klein), and then on wave spreading in wireless telegraphy. More significant is his major contribution to the development of the quantum theory, generally, and in its application to spectral lines and the Bohr atomic model. He evolved also a theory of the electron in the metallic state valuable to the study of thermo-electricity.

Sorby, Henry Clifton

English chemist and geologist

b. May 10, 1826, Woodbourne, nr. Sheffield

d. Mar. 9, 1908, Sheffield

Educated privately, and elected an F.R.S. in 1857, in 1863 Sorby invented the method of examining metals by treating polished surfaces with etching materials and examining them microscopically. He devised also a method of preparing thin slices of rock for the microscope, and studied in addition to geology and microscopy, biology, spectroscopy, architecture, archaeology and Egyptian hieroglyphics.

Sørensen, Søren Peter Lauritz

Danish biochemist

b. Jan. 9, 1868, Havrebjerg, Stagelae, Zealand

d. Feb., 1939, Copenhagen

Educated at Copenhagen, Sørensen became director of chemistry at the Carlsberg Laboratory. He is famous for his work on

SPAHLINGER

amino-acids, proteins and enzymes, and is sometimes referred to as the 'father of pH ,' because of his pioneer work on hydrogen-ion concentration. He invented the symbol pH for the negative logarithm of the hydrogen-ion concentration on the Sørensen scale.

Spahlinger, Henry

Swiss bacteriologist

b. Aug. 8, 1882, Geneva

Educated at Geneva, in 1912 Spahlinger was the discoverer of a serum which is used in the treatment of tuberculosis. The Great War interrupted his development of the serum but by the year 1919 the treatment was completed.

Spallanzani, Abbé Lazzaro

Italian biologist

b. Jan. 12, 1729, Scandiano, Modena

d. Feb. 11, 1799, Pavia

Educated at Bologna, Spallanzani was professor at Reggio, Modena and Pavia, and discovered artificial insemination. He showed that the sperms and not the surrounding liquid are the source of fertilising power. He did this by filtering off the sperms and proving the non-fertility of the liquid. He finally disposed of the idea of spontaneous generation by showing that micro-organisms do not develop in a flask that has been heated and sealed. His work included studies of the circulation of the blood, digestion and sense-perception in bats.

Spemann, Hans

German zoologist

b. June 27, 1869, Stuttgart

d. Sept. 12, 1941, Freiburg

Educated in Stuttgart, Spemann worked in his father's business of bookseller and publisher before going to Heidelberg to study medicine, and later to Würzburg. From being professor at Rostock he became director of the Kaiser Wilhelm Institute of Biology in 1914 and professor of zoology at Freiburg in 1919. He gained the Nobel prize for medicine in 1935 for his work on embryonic development, in particular for his discovery of what he

called the organiser function of certain tissues in such development.

Sperry, Elmer Ambrose

American inventor

b. Oct. 12, 1860, Cortland, N.Y.

d. June 16, 1930, Brooklyn

Beginning invention at an early age, Sperry produced many new electrical machines, e.g. coal-cutters, locomotives, etc., and he also invented a very efficient searchlight which became the standard pattern throughout the world. His most famous invention, however, was his gyroscopic compass, first used in 1911, which has rapidly replaced the magnetic type in all ships of sufficient size to warrant its installation.

Spottiswoode, William

English mathematician and physicist

b. Jan. 11, 1825, London

d. June 27, 1883, London

Educated at Oxford, Spottiswoode was engaged in the printing business (Eyre and Spottiswoode) but his spare time was devoted to research in mathematics and physics. He did original work on the polarisation of light and on electrical discharge in rarefied gases, and wrote a fine treatise on determinants. He was president of the British Association and of the Royal Society, and was elected F.R.S. in 1853.

Sprengel, Christian Konrad

German botanist

b. Sept. 22, 1750, Spandau

d. Apr. 7, 1816, Berlin

Educated for the Church, Sprengel became Rector of Spandau, but his interest in botany led him to neglect his duties to such an extent that he was removed from office. Living a life of seclusion and regarded as a crank, he nevertheless made important and original observations on pollination. He wrote a book on sex in plants (1793) which in spite of its brilliance was so unfavourably received as to discourage him to the extent of abandoning botany for philology. He pointed out, among other topics, the rôle of insects in pollination.

Sprengel, Hermann Johann Philipp

German-British chemist

b. Aug. 29, 1834, Schillerslage, Hanover

d. Jan. 14, 1906, London

Educated at Göttingen and Heidelberg, Sprengel came to Oxford and then to London to do research in chemistry, becoming a naturalised Briton. In 1865 he published *On the Vacuum*, in which his invention of a new type of vacuum pump, named after him, is described. This proved of great use in the researches on discharge tubes. He also devised the U-tube method for comparisons of liquid density. He was elected F.R.S. in 1878.

Spurr, Josiah Edward

American geologist

b. Oct. 1, 1870, Gloucester, Mass.

Educated at Harvard, Spurr became mining engineer to the Sultan of Turkey in 1901. In 1902 he became geologist in the U.S. Geological Survey, and after many technical appointments he became professor of geology at Rollins College (1930-32). He provided experimental data for an estimate of the age of the Tertiary period (45 to 60 million years). Mt. Spurr, Alaska, is named to commemorate his exploration of Alaska in 1896 and 1898. He wrote, among other books, *Geology Applied to Mining* (1904).

Stahl, Georg Ernst

German chemist and physician

b. Oct. 21, 1660, Ansbach, Bavaria

d. May 14, 1734, Berlin

Though an alchemist in his youth, Stahl later repudiated those practices and became professor of chemistry and medicine at Halle in 1694. He was the first to prepare glacial acetic acid. He was responsible with Becher for the theory of phlogiston which proved such a bugbear to chemists up to the time of Lavoisier. He was one of the early experimenters on oxidation and reduction. His medical writings (*Theoria Medica Vera*, 1707) expound his theory of animism, which identified the soul with the vital principle which governed organic development.

Stanhope, Charles, 3rd Earl

English scientist and politician

b. Aug. 3, 1753, London

d. Dec. 15, 1816, Chevening, Kent

Educated at Eton and Geneva, where he studied mathematics, Stanhope became a Member of Parliament without much success. He was the ridiculed 'minority of one' during the French Revolution. He carried his eccentricity into his private life, in which he neglected his children and his wives (the first of whom was the younger Pitt's sister) for his studies in science, invention and music. Most of his ideas were impracticable. He invented a cylindrical biconvex lens with ends of unequal curvature to correct spherical aberration, calculating machines, the first iron hand printing-press, and a method of stereotyping adopted by the Clarendon Press (1805). His eldest daughter became a goddess among the Druses of Lebanon.

Stanley, Wendell Meredith

American biochemist

b. Aug. 16, 1904, Ridgeville, Ind.

Educated at Earlham College and Illinois University, Stanley worked at the latter and at Munich, eventually becoming a member of the Rockefeller Institute for Medical Research (1940). His work on the chemical nature of viruses is outstanding. He was the first to isolate and crystallise a virus (the tobacco mosaic virus) and he worked on sterols and stereoisomerism. He has been the recipient of many high academic honours including the joint award (with Northrop and Sumner) of the Nobel prize for chemistry in 1946.

Stanley, William

American electrical engineer

b. Nov. 22, 1858, Brooklyn

d. 1916

After working originally for Maxim, Stanley eventually set up his own laboratory and gained fame as the inventor of the transformer. He also invented two-phase motors and new types of electrical measuring instruments. He devised a long-range transmission system for alternating current.

STARK

Stark, Johannes

German physicist

b. Apr. 15, 1874, Schickendorf, Bavaria
Educated at Munich, Stark went from Göttingen to Aix-la-Chapelle and then to Würzburg as professor of physics. In 1933 he became president of the Physikalische Technische Reichsanstalt. An authority on radiation and atomic theory, he was the discoverer of the Stark effect concerning the splitting of spectrum lines by subjecting the light source to a strong electrostatic field. He was awarded the Nobel prize for physics in 1919. He discovered the Doppler effect in canal rays. Like Lenard he welcomed the Nazi political and cultural theories.

Starling, Ernest Henry

English physiologist

b. Apr. 17, 1866, London

d. May 2, 1927, at sea

Educated at London and trained at Guy's Hospital, Starling became lecturer in physiology there and later professor at University College. He was the introducer of the term *hormones* for the internal secretions of the ductless glands. He was associated with Bayliss in the discovery of the intestinal hormone *secretin* (1902) and was an authority on the heart and its action. His *Principles of Human Physiology* appeared in 1912.

Stas, Jean Servais

Belgian chemist

b. Aug. 21, 1813, Louvain

d. Dec. 13, 1891, Brussels

Professor of chemistry at Brussels, Stas worked at first with Dumas, and later developed methods for the determination of atomic weights and analysis which were far in advance of any known at the time, though modern methods have corrected his results still further. He apparently disproved Prout's hypothesis. Stas was not popular in official scientific circles and led a quiet life without high academic distinction and in modest circumstances.

Steenstrup, Johann Japetus

Danish zoologist

b. Mar. 8, 1813, Vang, Norway

d. June 20, 1897, Copenhagen

Professor of zoology at Copenhagen and the discoverer, independently of Chamisso, of the important process of heredity known as the alternation of generations, Steenstrup published a work on this subject entitled the *Propagation and Development of Animals through Alternate Generations* (1892). He showed that certain animals such as jelly-fish produce offspring which resemble their grandparents or remoter ancestors but never the parents. This process has proved to be of great importance in plant life and led to the discovery of the alternation of sexual and parthenogenetic reproduction. He wrote also on hermaphroditism in nature and cephalopods.

Stefan, Josef

Austrian physicist

b. Mar. 24, 1835, St. Peter, nr. Klagenfurt

d. Jan. 7, 1893, Vienna

Professor of physics in Vienna in 1863, Stefan proposed a law of radiation stating that the amount of energy radiated per sec. from a black body is proportional to the fourth power of the absolute temperature. This is known as Stefan's law or the Stefan-Boltzmann law. He studied also electricity, kinetic theory of gases and hydrodynamics.

Steno, Nicolaus, or Niels Stensen

Danish anatomist and geologist

b. Jan. 10, 1638, Copenhagen

d. Dec. 6, 1687, Schwerin

Trained in medicine, Steno eventually specialised in geology. He was brought up a strict Lutheran but settled in Florence and in 1667 turned Roman Catholic, becoming a bishop, and in 1677 vicar-apostolic to N. Germany. He was the first to point out the true origin of fossil animals (1669), to give an explanation of the earth's crust, and to differentiate between volcanic and stratified rocks. As a physician he acquired a considerable reputation by his researches into glands, brain and heart, discovering the Stenonian duct (of the parotid gland), and explaining the function of the ovaries.

Stephenson, George

English engineer

b. June 9, 1781, Wylam, nr. Newcastle-on-Tyne

d. Aug. 12, 1848, Chesterfield

The son of a fireman, Stephenson had a hard struggle to educate himself, and a very slow rise to the position of engineer at Killingworth Pit. Though chiefly famous for his invention of a successful steam-engine, he invented also a safety lamp for mines at about the same time as Davy, which caused the usual controversy as to priority. His first locomotive was the *Blucher*, but the one actually used to draw the first passenger train was the *Active*, renamed *Locomotion*. In 1829 he won the Rainhill competition for the Liverpool and Manchester railway with his celebrated *Rocket*. He was engineer on the construction of several railways, beginning with Hetton Colliery railway, 8 miles long, opened 1822. With his cousin and Pease he opened locomotive works near Newcastle in 1823.

Stern, Otto

German-American physicist

b. Feb. 17, 1888, Sohrau, Germany

Educated at Breslau, Stern worked at Zürich, Frankfurt (1915-21), Rostock (1921-22) and Hamburg (1925-33) before going to America as research professor of physics at the Carnegie Technical Institute in 1933. He studied thermodynamics, kinetic theory of gases and quantum theory. He was awarded the Nobel prize for physics in 1943 for his work on magnetic moment of the proton and his development of the molecular-ray method of studying atomic particles.

Stevinus, Simon (or Stevin)

Dutch mathematician

b. 1548, Bruges

d. 1620, Hague

Originally a merchant's clerk, Stevinus became quartermaster-general of the Dutch army, and is credited with the introduction of decimal fractions into general use. Famous for his discoveries in statics and hydrostatics, one of which was the triangle of forces, he also distinguished between

stable and unstable equilibria. He invented a yacht on wheels which carried 28 people and easily outstripped horses. A clear thinker, he had a considerable contempt for those who could not follow his work.

Stokes, Sir George Gabriel, Bart.

British mathematician and physicist

b. Aug. 13, 1819, Sligo

d. Feb. 1, 1903, Cambridge

Educated at Cambridge, Stokes became a fellow of Pembroke College in 1841 and professor of mathematics in 1849. He was Member of Parliament for Cambridge from 1887 to 1892, president of the Royal Society from 1885 to 1890, and was awarded the Copley medal in 1893. An eminent worker in mathematical physics, he was the originator of the idea of determining the chemical compositions of the sun and stars from their spectra. He published a valuable report on double refraction, and correctly identified X-rays as electromagnetic waves produced by sudden obstruction of cathode rays, deducing their short wavelength from the absence of regular reflection and refraction. He investigated fluorescence caused by the different parts of the spectrum and confirmed that violet and ultra-violet rays are most active in this connection. Stokes' law states a formula for the force opposing a small sphere in its passage through a viscous fluid.

Stoney, George Johnstone

Irish mathematical physicist

b. Feb. 15, 1826, Oakley Park, Ireland

d. July 5, 1911, London

Educated at Dublin, Stoney became professor of natural philosophy at Queen's College, Galway, in 1852, secretary, Queen's University 1857, and an F.R.S. in 1861. He introduced the term *electron* and in 1874 calculated an approximate value for its charge. He studied also optics, molecular physics, gases, and planetary atmospheres.

Störmer, Carl Fredrik Mülertz

Norwegian mathematician and geophysicist

b. 1874

STORY-MASKELYNE

Educated at Oslo University, Störmer became professor at the Institute for Theoretical Astrophysics there in 1903. He carried out original research on polar lights, noctilucent clouds and related atmospheric phenomena, also on cosmic rays. In connection with the approach of cosmic rays to a magnetic dipole he discovered the so-called forbidden directions which lie within a cone known as the Störmer cone. The unit of momentum at which a particle can circle round the equator near the earth's surface is called a störmer and is equal to 59,500 Me V/c.

Story-Maskelyne, Mervyn Herbert Nevil
English mineralogist

b. Sept. 3, 1823, Wroughton, Wiltshire

d. May 20, 1911, Wroughton

Educated at Oxford, Story-Maskelyne became professor of mineralogy there (1856) and keeper of minerals at the British Museum (1857). He extensively reorganised the exhibits and it is to him that the bulk of the present fine collection is due. He was elected F.R.S. in 1870, and was an M.P. 1880-92. His *Morphology of Crystals* (1895) was well-known. In 1894 he introduced the term *solute* to describe the solid part of a solution.

Stromeyer, Friedrich

German chemist

b. 1776, Göttingen

d. 1835, Göttingen

Educated at Göttingen and Paris, Stromeyer became professor of chemistry at the former university. He is known for his analysis of minerals and for his discovery of cadmium in 1817.

Struve, Friedrich Georg Wilhelm

German astronomer

b. Apr. 15, 1793, Altona, nr. Hamburg

d. Nov. 23, 1864, St. Petersburg

Educated at Dorpat, Struve became director of the observatory there (1817) and later at Pulkova, St. Petersburg (1834). He was an authority on double stars and nebulae and was one of the first to measure a stellar parallax (alpha Lyrae).

Struve, Otto Wilhelm

German astronomer

b. May 7, 1819, Dorpat

d. Apr. 14, 1905, Karlsruhe

The son of Friedrich and his successor at Pulkova, Otto Struve continued his father's work, discovering some five hundred new double stars, and calculated the constant of precession. He made studies of the mass of Neptune, Saturn's rings and the sun's velocity. Otto's elder son, Hermann (1854-1920), was director of the Berlin observatory (1904), and superintended the removal to Babelsberg. He was succeeded in 1919 by his son Georg (b. 1886). Otto Wilhelm's other son, Ludwig (1858-1920), was professor and director of the University of Kharkov observatory (1894) and did work on the proper motion of the solar system. His son, Otto (b. 1897), went to America (1921), became naturalised and after various academic posts became director of the Yerkes and McDonald observatories (1932).

Sturgeon, William

English scientist

b. May 22, 1783, Whittington, Derbyshire

d. Dec. 4, 1850, Prestwich, Lancs.

The son of a Lancashire shoemaker, and a self-taught scientist, in 1825 Sturgeon constructed the first useful electromagnet from bare copper wire wrapped round a varnished soft iron horseshoe. It lifted twenty times its own weight. He devised the first moving-coil galvanometer (1836) and an electromagnetic rotary engine. His *Annals of Electricity* was the first electrical journal in Britain (1836).

Sturm, Jacques Charles François

French mathematician

b. Sept. 29, 1803, Geneva

d. Dec. 18, 1855, Paris

A professor of mathematics at the Polytechnic, Paris (1840), and professor of mechanics at the Faculty of Sciences at Paris later, Sturm discovered a famous theorem named after him concerning the real roots of an equation. With Colladon in 1826 he measured the velocity of sound in water by using a bell submerged in Lake Geneva.

Sugden, Samuel

English chemist

b. 1892, Leeds

d. Oct. 20, 1950

Educated at London, Sugden became professor of physical chemistry at Birkbeck College in 1932 and professor of chemistry at University College, London, in 1937. He was elected F.R.S. in 1934. He is noted for his original work on molecular volumes and surface tension and has done much to further the study of structure. The *parachor*, which he introduced, overcomes the difficulty of the attractive forces between molecules in work on molecular dimensions based on molecular volumes. See *The Parachor and Valency* (1929).

Sumner, James Batcheller

American biochemist

b. Nov. 19, 1887, Canton, Mass.

Educated at Harvard, Sumner eventually became professor of biochemistry at Cornell in 1929. He is noted for his research on enzymes and proteins and was awarded the Nobel prize for chemistry in 1946 jointly with W. M. Stanley and Northrop (qq.v.).

Svedberg, Theodor

Swedish chemist

b. Aug. 30, 1884, Valbo, Gävleborgs

Educated at Uppsala, Svedberg rose to be professor there and director of the Institute of Physical Chemistry. An authority on colloid chemistry (dispersed phase), he gained the Nobel prize for chemistry in 1926, and is the author of several works on the subject. He developed his remarkable ultracentrifuge for the determination of the size of colloidal particles and protein molecules in a centrifugal field.

Swammerdam, Jan

Dutch naturalist

b. Feb. 12, 1637, Amsterdam

d. Feb. 15, 1680, Amsterdam

The son of a chemist, Swammerdam was educated in medicine at Leyden and developed a passion for natural history. He went to Paris and became known through his book on insects, which with

its classification according to development laid the foundations of entomology. He was subject to attacks of depression and mental instability and he burnt many of his works previous to his early death from malaria. His manuscripts and drawings were edited by Boerhaave under the title of the *Biblia Naturae* (1737-38), the finest collection of microscopical observations ever produced by one man. He disproved the belief held at the time that muscles increase in volume during contraction. In 1658 he observed red blood corpuscles for the first time; and in 1664 discovered the valves in the lymph vessels and the Swammerdam glands in Amphibia. He was the first to inject blood-vessels with wax and dyes. He finally joined the Bourignon sect, and abandoned science.

Swan, Sir Joseph Wilson

English physicist

b. Oct. 31, 1828, Sunderland

d. May 27, 1914, Warlingham, Surrey

After serving as a chemist's assistant, Swan became a manufacturing chemist. This led to his invention of the dry plate for photography. He also patented bromide paper in 1879 and introduced a satisfactory method of carbon printing. In 1860 he invented an electric lamp which was the prototype of Edison's which appeared nearly twenty years later, and did much work on the production of suitable filaments. He was the first to produce a practicable artificial silk. Swan was a fellow of the Royal Society and was knighted in 1904.

Sydenham, Thomas

English physician

b. Sept. 10, 1624, Wynford Eagle, Dorset

d. Dec. 29, 1689, London

Sydenham's studies at Oxford were interrupted by the Civil War, in which he served in the Parliamentarian forces. He began practice in London in 1655, though without the licence of the College of Physicians. 'The English Hippocrates', whose name it is said Boerhaave never spoke without raising his hat, quickly became famous for his writings and practice. As becomes the friend of Boyle and

SYLVIVS

Locke, he laid valuable emphasis on clinical observation and experience. He gave classic descriptions of gout, venereal disease, fevers, hysteria and Sydenham's chorea (mild convulsions in children); and elaborated theories of prevailing causes and treatment of epidemics.

Sylvius, Fransiscus or Franz de la Boë
Flemish chemist and physiologist

b. 1614, Hanau

d. Nov. 14, 1672, Leyden

A professor of medicine at Leyden, Sylvius did much towards the introduction of new ideas into his subject. In his study of the body juices, pancreatic, saliva, bile, etc., he was one of the earliest to apply chemistry to medicine. He discovered the fissure in the brain which bears his name, and was one of the first to appreciate the idea of chemical affinity.

He demonstrated the significance of lung nodules in pulmonary tuberculosis.

Szent-Györgyi, Albert, von Nagyrápolc
Hungarian biochemist

b. Sept. 16, 1893, Budapest

Educated at Budapest, Szent-Györgyi lectured at Groningen and Cambridge before becoming professor of medical chemistry (1930) and organic chemistry (1935) at Szeged, Hungary, and in 1938 at Liège. At Cambridge he isolated Vitamin C (ascorbic acid), and later prepared quantities of it from Hungarian paprika. This work gained him the Nobel prize for medicine in 1937. He investigated also biological combustion, carbohydrate metabolism, muscle contraction and phosphorous compounds, and cellular oxidation. In 1939 he published *On Oxidation, Fermentation, Vitamins, Health and Disease*.

T

Tagliacozzi, Gasparo

Italian surgeon

b. 1546, Bologna

d. Nov. 7, 1599, Bologna

The first plastic surgeon, Tagliacozzi was the inventor of rhinoplasty. He succeeded in grafting a piece of skin from a patient's arm on to his nose. This operation was not approved of by the Church as it was regarded as an interference with God's purpose, so it was not repeated for about three hundred years. He was professor of anatomy and surgery at Bologna, and published his *De curtorum chirurgia per insitionem* in 1597.

Tait, Peter Guthrie

Scottish mathematician and physicist

b. Apr. 28, 1831, Dalkeith, Midlothian

d. July 4, 1901, Edinburgh

Educated at Edinburgh and Cambridge, in 1854 Tait became professor of mathematics at Belfast, and in 1860 moved to Edinburgh as professor of natural philosophy. He wrote a great number of books on physics and also on religion on which he felt very deeply. He designed a piece of apparatus to produce large vortex rings, and apart from his more serious work his experiments and theory on the flight of a golf ball aroused a great deal of general interest. He wrote a standard treatise on quaternions, and investigated ozone, gases and electricity.

Talbot, William Henry Fox

English physicist

b. Feb. 11, 1800, Lacock Abbey, Wilts.

d. Sept. 17, 1877, Lacock Abbey

Educated at Cambridge, Talbot was a pioneer in optics and photography, and succeeded in 1839 in making negative prints on silver chloride paper. In 1841 he invented the calotype process for making positives (patented 1841), and in 1851 devised a method of instantaneous photography. He was an early investigator

of the spectrum and was able to distinguish the flames of lithium and strontium with a prism. His versatility is illustrated by his being also one of the first to read the Assyrian cuneiform inscriptions at Nineveh.

Tansley, Sir Arthur George

English botanist

b. 1871, London

Educated at London and Cambridge, Tansley became assistant professor of botany at University College, London, in 1893, and lecturer at Cambridge in 1906. From 1927 to 1937 he was Sherardian professor of botany at Oxford, having been elected F.R.S. in 1915. He is noted for his text-books on botany and founded *The New Phytologist* in 1902, being editor for thirty years. He also edited the *Journal of Ecology* for twenty-one years. Among his works are *The British Islands and their Vegetation* (1939) and *Britain's Green Mantle* (1949).

Taylor, Brook

English mathematician

b. Aug. 18, 1685, Edmonton, Middlesex

d. Dec. 29, 1731, London

Educated at Cambridge, Taylor wrote various papers on the mathematics of physical problems (including a solution of the centre of oscillation). He is chiefly remembered for his discovery of the theorem, named after him, of considerable use in higher mathematics :

$$f(x+h) = f(x) + hf'(x) + \frac{1}{2!}h^2f''(x) + \dots$$

His *Methodus Incrementorum Directa et Inversa* (1715) laid the foundation of the calculus of finite differences. He was elected F.R.S. in 1712 and was secretary to the society for four years.

Teisserenc de Bort, Léon Philippe

French meteorologist

b. Nov. 5, 1855, Paris

d. Jan. 2, 1913, Cannes

TENNANT

Employed in the Bureau Central Météorologique in Paris, Teisserenc became chief meteorologist there. He was an authority on the upper atmosphere and discovered the isothermal layer which he named the stratosphere, as distinct from the troposphere below.

Tennant, Smithson

English chemist

b. Nov. 30, 1761, Selby, Wensleydale, Yorks.

d. Feb. 22, 1815, Boulogne

Educated at Edinburgh and Cambridge, where he took a degree in medicine, Tennant specialised in chemical research. He is noted for his discovery of the two elements osmium and iridium in 1804, which names he gave them because of their properties. He also proved by experiment that a diamond is pure carbon. In 1814 he became professor of chemistry at Cambridge, but was killed in a riding accident in the following year.

Terman, Lewis Madison

American psychologist

b. Jan. 15, 1877, Johnson County, Ind.

Educated at Danville, Indiana, Clark and California, Terman eventually became professor of psychology at Stanford (1916). He has done much work on intelligence testing, especially in connection with the American army, and has introduced modifications to existing tests (Binet-Simon) and the new Terman Group Test (1920). He has also in collaboration with others published many works on the subject.

Thalen, Tobias Robert

Swedish physicist

b. 1827

d. 1905

A pioneer in the spectroscopy of the rare earths, Thalen wrote a famous book on spectrum analysis. He also did research on the magnetic properties of iron and its ores.

Thales

Greek mathematician and astronomer

b. c. 640 B.C., Miletus

d. c. 546 B.C.

A merchant who turned to the study of mathematics and astronomy, and one of the Seven Wise Men of Greece, Thales is sometimes regarded as the first scientist. He predicted an eclipse of the sun for May 28, 585 B.C., the first scientific prediction of this kind on record, and he is credited with the discovery of static electricity, being aware that amber when rubbed with silk would attract light objects. In geometry, to which he gave the first impetus in Greece, he calculated the height of a pyramid from the length of its shadow compared with the shadow of a post of given height, and he is credited with the discovery of several well-known theorems concerning isosceles triangles, intersecting lines, the angle in a semi-circle, etc. He believed the earth to be a flat disc floating in water, and water, he taught, was the prime element.

Thenard, Baron Louis Jacques (*often* Thénard)

French chemist

b. May 4, 1777, Louptière, Aube

d. June 21, 1857, Paris

The son of a peasant, Thenard started as laboratory assistant and rose to be professor of chemistry at the Collège de France. He was associated for a long time with Gay-Lussac in work on chlorine and the alkali metals, discovering sodium and potassium peroxides. They also showed that caustic soda and potash contain hydrogen as well as oxygen. He discovered hydrogen peroxide and became wealthy through the discovery of Thenard's blue, used in colouring porcelain. He was the author of a standard work *Traité Élémentaire de Chimie Théorique et Pratique* (1813-16). He was raised to the peerage (1824) and became chancellor of the University of Paris.

Thomas, Hugh Owen

Welsh orthopaedic surgeon

b. 1833, Anglesey

d. 1891, Liverpool

Owen studied medicine at University College, London, Edinburgh University and in Paris. In 1857 he began surgical practice in the dock area of Liverpool.

where he soon became interested in orthopaedics, and gained a reputation as a 'club-doctor.' He developed many appliances for the treatment of bones and joints, among them the invaluable Thomas' splint for hip and knee, and his work, though its acceptance was retarded by his obscurity, established modern orthopaedic surgery. He published *Diseases of the Hip, Knee and Ankle joints* in 1875.

Thomas, Sidney Gilchrist

English inventor

b. Apr. 16, 1850, Canonbury, London

d. Feb. 1, 1885, Paris

Beginning as a clerk in a police court, Thomas studied chemistry at Birkbeck, and later solved the problem of separating the phosphorus impurity from iron in the Bessemer converter (basic Bessemer process). This was of great importance on the Continent, more so than in England where the iron ore, except in the Cleveland district of north Yorkshire, is comparatively free from phosphorus.

Thompson, Benjamin. See **Rumford, Count.**

Thompson, John Vaughan

English surgeon

b. Nov. 19, 1779

d. Jan. 21, 1847, Sydney, N.S.W.

After being an army surgeon, Thompson settled in Cork in 1816 and spent twenty years studying marine zoology. He wrote very little but what he did publish was excellent. His work on the life-cycles of the common crab and the barnacle was outstanding.

Thomson, Sir Charles Wyville

Scottish biologist

b. Mar. 5, 1830, Bonsyde, Linlithgow

d. Mar. 10, 1882, Bonsyde

Educated at Edinburgh, Thomson became professor of natural history there in 1870 after holding posts at Aberdeen and Belfast. He was famous for his deep sea researches (1868 onwards) and he was put in charge of the scientific side of the *Challenger* expedition (1872-6). He published *The Voyage of the Challenger* (1877).

He was elected F.R.S. in 1869, and wrote *The Depths of the Sea* in 1872.

Thomson, Sir George Paget

British physicist

b. May 3, 1892, Cambridge

The son of Sir J. J. Thomsop, educated at Cambridge, Thomson became F.R.S. in 1929. In 1922, after service in the Royal Air Force, he became professor of natural philosophy at Aberdeen, and in 1930 moved to London as professor of physics. He discovered the diffraction of electrons by crystals (1927) and was awarded the Nobel prize for physics in 1937 jointly with Davisson, who made the same discovery by a different method.

Thomson, James

British physicist

b. Feb. 16, 1822, Belfast

d. May 8, 1892, Glasgow

A brother of Lord Kelvin, James Thomson was educated at Glasgow as a civil engineer and became professor of engineering there. He is known for his theoretical investigation of the variation in melting point with pressure, experimentally verified by Lord Kelvin; and also for his work in hydraulics.

Thomson, Sir John Arthur

Scottish naturalist

b. July 8, 1861, Salton, East Lothian

d. Feb. 12, 1933, Limpsfield, Surrey

Educated at Edinburgh, Jena and Berlin, Thomson became professor of natural history at Aberdeen in 1899. Noted for his work in zoology (on alcyonarians) he also wrote many books on biology both popular and technical.

Thomson, Sir Joseph John

British physicist

b. Dec. 18, 1856, Manchester

d. Aug. 30, 1940, Manchester

Educated at Manchester and Cambridge, in 1884 Thomson became professor of physics at the latter university, in 1905 at the Royal Institution, and in 1918 Master of Trinity College. He organised the Cavendish research laboratory there. He was elected F.R.S. in 1884, was

THOMSON



SIR JOSEPH JOHN THOMSON, founder of the world-famous Cavendish School of nuclear physics.

awarded the Nobel prize in 1906, and became president of the Royal Society in 1915. He was president of the British Association in 1909, was knighted in 1908 and became a member of the Order of Merit in 1912. His early work was on the application of dynamics to physics and chemistry, on the study of vortices, and the mass of electrified particles. In 1897 his researches on electrical conduction in gases led to the more important discovery that cathode rays consisted of negatively charged particles (electrons). The discovery of the electron inaugurated the electrical theory of the atom; and this, with his elucidation of positive rays (1911) and their application to an analysis of neon, which led to Aston's work with the mass-spectrograph and the discovery of isotopes, entitle Thomson to be regarded as the founder of modern atomic physics. Under his direction the teaching at the Cavendish laboratory became world-famous, and many of the most prominent figures of subsequent atomic research studied there. He was the author of

many books and papers, including *Applications of Dynamics to Physics and Chemistry* (1888), *The Conduction of Electricity through Gases* (1903), *Rays of Positive Electricity and their Application to Chemical Analysis* (1913), and *The Electron in Chemistry* (1923). See Lord Rayleigh, Sir J. J. Thomson (1942), and *History of the Cavendish Laboratory* (1910).

Thomson, Thomas

Scottish chemist

b. Apr. 12, 1773, Crieff

d. July 2, 1852, Kilmun, Argyllshire

Professor of chemistry at Glasgow (1818), Thomson opened there in 1817 the first laboratory for students in Britain. The 3rd ed. of his *System of Chemistry* (1807) contained the first exposition of Dalton's atomic theory.

Thomson, William. See Kelvin, Lord

Thorndike, Edward Lee

American educational psychologist

b. Aug. 31, 1874, Williamsburg, Mass.

d. Aug., 1949

Thorndike studied at Wesleyan University, and at Harvard under William James, specialising in the study of animal learning processes. In 1898 he went to Columbia, where he was professor from 1904-40. From his work on animal learning he formulated his influential theories in educational psychology (*The Principles of Teaching*, 1905; *Psychology of Learning*, 1914; *Psychology of Arithmetic*, 1922; and of *Algebra*, 1923). He stressed the effect of chance associations, such as the mental accompaniment of success or failure (so-called Law of Effect) as important processes in learning, and his mechanistic approach, though controversial, proved a stimulus to behaviour research. He also devised intelligence tests (*The Measurement of Intelligence*, 1926).

Thorpe, Sir Thomas Edward

English chemist

b. Dec. 8, 1845, Harpurhey, Manchester

d. Feb. 23, 1925, Salcombe, Devon

Educated at Manchester and Heidelberg, Thorpe held professorships at Glasgow

Leeds and South Kensington, was government chemist from 1894-1909, and was elected F.R.S. in 1876. He made some accurate atomic weight determinations, and many discoveries of new compounds. With Roger he studied the viscosity of liquids and discovered a formula for the coefficient. He was the author of books on chemical analysis, a dictionary, a history of chemistry, and other works.

Tiemann, Johann Karl Ferdinand

German chemist

b. 1848, Rübeland, Harz

d. 1899

After starting in pharmaceutical chemistry Tiemann soon transferred to organic and worked under Hofmann in Berlin. He became professor in Berlin in 1882. He is famous for his researches on the nitriles, terpenes and camphors and was successful in the synthesis of vanillin, used in confectionery as vanilla flavouring.

Tilden, Sir William Augustus

English chemist

b. Aug. 15, 1842, St. Pancras, London

d. Dec. 11, 1926

Trained at the College of Chemistry, Tilden became professor of chemistry at Birmingham and then at the Royal College of Science, London. He was the first to obtain isoprene synthetically; this he did by passing turpentine vapour through a red-hot tube. This led directly to the production of synthetic rubber. He was known also for his general work on organic bases, alkaloids and specific heats of elements.

Tiselius, Arne Wilhelm Kaurin

Swedish chemist

b. 1902

After working with Svedberg at the Physical Chemistry Institute, Tiselius was appointed to the newly-formed chair of biochemistry at Uppsala (1938). He is known for his work on serum proteins and on chromatography, especially for his electrophoretic analysis, which provides tests and analyses of proteins and complex systems such as sera. In chromatography he has evolved methods for the adsorption

analysis of colourless substances. He gained the Nobel prize for chemistry in 1948.

Tizard, Sir Henry Thomas

English scientist

b. Aug. 23, 1835

Educated at Oxford, Tizard lectured at Oriel College before leaving for aeronautical research in the R.A.F. Later he became secretary of the Department of Scientific and Industrial Research. He has served on many government committees connected with aircraft production and was president of the British Association in 1948. In 1942 he was the first scientist to be elected president of an Oxford College (Magdalen).

Todd, Alexander Robertus

Scottish chemist

b. Oct. 2, 1907, Glasgow

A professor first at Manchester (1938), then Cambridge (1944), Todd is distinguished for his investigations in the chemistry of naturally occurring products, notably vitamins B₁ and E.

Tollens, Bernhard Christian Gottfried

German chemist

b. 1841

d. 1918

Professor of agricultural chemistry at Göttingen, Tollens synthesised toluene in 1864 with Fittig.

Tombaugh, Clyde William

American astronomer

b. Feb. 4, 1906, Strator, Ill.

Educated at Kansas, Tombaugh was assistant at the Lowell Observatory, Flagstaff, before going to Arizona State College and then as professor of astronomy to California. In 1946 he became astronomer at the Aberdeen Ballistics Laboratories, Las Cruces, New Mexico. He is famous for his discovery of the planet Pluto in 1930, the existence of which had been predicted by Lowell. He has also discovered new galactic star clusters and similar objects and has done research on the geology of the moon's surface.

TORRICELLI

Torricelli, Evangelista

Italian physicist

b. Oct. 15, 1608, Faenza, Emilia

d. Oct. 25, 1647, Florence

After studying at Rome Torricelli succeeded Galileo as professor of mathematics at Florence. He is famous for his experiment in which he made a barometric column by inverting a column of mercury under the same liquid (1643). He built also a primitive microscope, improved the telescope, and investigated the cycloid.

Townsend, Sir John Sealy Edward

Irish physicist

b. June 7, 1868, Galway

Educated at Dublin, Townsend was demonstrator at the Cavendish Laboratory, Cambridge, before becoming professor of physics at Oxford (1900). He was elected F.R.S. in 1903, and is well known for his work on the theory of ionisation of gases by collision, and in general on all aspects of electricity in gases. He calculated (1897) the charge on a single gaseous ion. *The Theory of Ionisation of Gases by Collision* (1910), *Electricity in Gases* (1915), *Motions of Electrons in Gases* (1925) embody the results of his experiments.

Traube, Ludwig

German physician and pathologist

b. Jan. 12, 1818, Ratibor

d. Apr. 11, 1876, Berlin

The elder brother of Moritz, Ludwig Traube studied under Johannes Muller, and became a professor at the Charité, Berlin (1853), the Friedrich-Wilhelm Institute (1857), and the University (1872). He may be regarded as the founder of the study of experimental pathology in Germany, by his use of experiments on animals to solve clinical problems. He also furthered the use of auscultation and percussion, and of the thermometer in diagnostics.

Traube, Moritz

German chemist

b. Feb. 12, 1826, Ratibor

d. June 28, 1894, Berlin

At Breslau in 1867 Traube produced artificial semipermeable membranes, which

opened the door to the measurement of osmotic pressure. He worked also on sugars, plant respiration, fermentation, protoplasm, and muscles and oxidation.

Travers, Morris William

English chemist

b. Jan. 24, 1872, London

Educated at London and Nancy, Travers became president of the Society of Glass Technology, a subject upon which he is an authority. He was professor at University College, Bristol, from 1904-37 and technical consultant to the Ministry of Supply from 1940-45. With Ramsay, between 1894 and 1908, he discovered the inert gases krypton, xenon and neon by allowing a quantity of liquid air to evaporate slowly and examining the spectrum of the last traces of gas given off. He investigated also the phenomena of low temperatures and was the author of *The Discovery of the Rare Gases* (1928).

Treves, Sir Frederick

English surgeon

b. Feb. 15, 1853, Dorchester

d. Dec. 7, 1923, Vevey, Switz.

Educated in London, Treves became professor of pathology and later of anatomy at the Royal College of Surgeons. A founder of the British Red Cross Society, he was famous for his investigations of and operations for appendicitis, culminating in his successful treatment of Edward VII in 1902, and he wrote many important medical text-books.

Treviranus, Gottfried Reinhold

German naturalist and physician

b. Feb. 4, 1776, Bremen

d. Feb. 16, 1837, Bremen

A famous biologist, and professor at the Bremen Lyceum, whose work was preparatory to later evolutionary theory, Treviranus coined the term *botany* (as did also Lamarck), and did much towards the linkage of the various groups of natural sciences into the concept of biology. His important *Biologie oder die Philosophie der lebenden Natur* (1802-22) explained his conception of 'descent with modification' by physical influences.

Treviranus, Ludolf Christian

German naturalist

b. Sep. 18, 1779, Bremen

d. May 6, 1864, Bonn

Brother of Gottfried (*above*), and professor at Bremen, Rostock, Breslau and Bonn. Ludolf also was an eminent biologist, noted for his discovery of intercellular spaces.

Trevithick, Richard

English engineer

b. Apr. 13, 1771, Illogan, Cornwall

d. Apr. 22, 1833, Dartford, Kent

The son of a mines manager, Trevithick, an engineer in a Cornish mine, took to invention and produced a pump and a pioneer high pressure steam-engine (1800). He is best remembered for his invention of the road locomotive, and in 1801 his model carried passengers for the first time. Subsequently he spent his life in the application of steam to transport, agriculture and mine engines, but obtained little reward for his activities, dying penniless. He demonstrated that smooth flange wheels on a smooth rail generate enough friction for traction, and built the first steam rail locomotive, which, in February, 1804, pulled 5 waggons, 70 passengers, and 10 tons of iron for 9½ miles at 5 m.p.h.

Tswett, Mikhail Semenovitch (or Tsvett)

Russian botanist

b. 1872

d. 1919.

In 1906 Tswett, while working on plant pigments, devised a percolation method of separating them by extracting the leaves with petrol and percolating the solution through calcium carbonate; the pigments are then deposited in horizontal bands. This was the first chromatographic analysis and the pattern of bands is known as a chromatogram. Tswett's example was, however, not followed until some thirty years later. In 1941, and subsequently, modifications such as silica gel were introduced; and the mathematical basis was elaborated according to the Langmuir and Freundlich adsorption isotherms.

Turner, Edward

English chemist

b. 1798, Jamaica

d. Feb. 13, 1857, London

Educated at Edinburgh and Göttingen, Turner became the first professor of chemistry at University College, London. He made some excellent determinations of atomic weights in 1833.

Turner, William

English physician and botanist

b. c. 1520, Morpeth, Northumberland

d. July 7, 1568, London

Educated at Cambridge, Turner became Dean of Wells though at one time he had been imprisoned for preaching without licence. His interest in botany resulted in his *Libellus de re herbaria* (1538), the first essay on botany to be written in England. In his foreign travels he met and became friends with Conrad Gesner, the famous naturalist, and he can be said to be the first English scientific botanist, naming many plants such as *goatsbeard*, *hawkweed*, etc. His *Neue Herball* (1551) introduced the new scientific botany from the Continent. He had a stormy life, being in and out of favour with the authorities according as to who was the reigning monarch.

Twort, Frederick William

English bacteriologist

b. Oct. 22, 1877, Camberley, Surrey

d. Mar. 20, 1950, Camberley

Twort worked during 1901-2 in the clinical laboratory of St. Thomas' Hospital, where he had been trained in medicine, and was subsequently (1902-9) assistant bacteriologist to the London Hospital, superintendent of the Brown Institution (1909), and professor of bacteriology in the University of London. He studied John's disease (an intestinal infection of ruminants), and described in 1910 a method for the culture of acid-fast leprosy bacilli. In 1915 he described in *The Lancet* his discovery of the bacteriophage, the filterable virus which parasitises and destroys certain bacteria.

TYNDALL

Tyndall, John

Irish physicist

b. Aug. 2, 1820, County Carlow

d. Dec. 4, 1893, Hindhead, Surrey

Largely self-educated, Tyndall was connected with the Ordnance Survey and later went abroad to study under Bunsen. He became professor of natural philosophy at the Royal Institution in 1854, an F.R.S. in 1852, and in 1867 succeeded Faraday as superintendent of the Royal Institution. He was a prolific writer on all branches of science. He conducted a series of experiments on temperature waves in metals, and proved that the rate of transmission

does not depend on the conductivity of the metal. He also carried out original research on the diathermancy of gases, and came to the conclusion that they are not perfectly transparent to thermal radiations. He suggested that the blue of the sky is caused by scattering from very small particles of water suspended in the upper atmosphere, and his experiments on the physical conditions of aerial purity did much to destroy the remnants of belief in 'spontaneous generation.' He discovered the effect of atmospheric density on sound transmission. Tyndall was one of the most eminent of teachers and writers of his day.

U

Unverdorben, Otto

German chemist

b. Oct. 13, 1806, Dahme, nr. Potsdam

d. Dec. 28, 1873, Dahme

After studying chemistry in the early part of his life, Unverdorben later abandoned it for a commercial career. In 1826 he was the first to prepare aniline by the distillation of indigo. He named it crystalline, but in 1841 it was renamed by Fritzsche.

Urbain, Georges

French chemist

b. Apr. 12, 1872, Paris

d. Nov. 5, 1938, Paris

Educated at Paris, Urbain eventually became professor of inorganic chemistry at the Sorbonne (1908). In 1907 he discovered the rare earth lutecia, and so named it from the ancient name for Paris. He made considerable contributions to the knowledge of the rare earths generally, showing that several elements, hitherto considered pure, are in fact mixtures. He discovered the law of optimum phosphorescence of binary systems, and studied complex inorganic salts.

Urey, Harold Clayton

American chemist

b. Apr. 29, 1893, Walkerton, Ind.

Educated at Montana, California and Copenhagen, Urey eventually became professor of chemistry at Columbia in 1934. In the same year he was awarded



HAROLD CLAYTON UREY, the world's foremost authority on isotopes

the Nobel prize for chemistry. He went to a professorial chair in Chicago in 1945. In 1932 at Columbia he was the first to isolate heavy water (deuterium oxide) and hence to discover the heavy isotope of hydrogen (mass 2) named deuterium. This was of value in the development of the atomic bomb. He did work also on the entropy of gases, atomic and molecular structure, absorption spectra and isotopes. He is probably the most eminent authority of the day on the separation of isotopes.

V

Vallisnieri, Antonio

Italian scientist

b. May 3, 1661, Château Tresilico, Modena
d. Jan. 28, 1730, Padua

Professor of medicine at Padua, Vallisnieri wrote treatises on the ostrich in 1712 and the chameleon in 1715, and was the first to recognise the nature of a geological fault. The water-weed *Vallisneria spiralis* is named after him; and he made studies of the reproductive systems of insects.

Vauquelin, Louis Nicolas

French chemist

b. May 16, 1763, St. André d'Hébertot
Normandy

d. Nov. 14, 1829, St. André d'Hébertot
Commencing as a laboratory assistant, Vauquelin rose to be professor of chemistry at Paris (1809). In 1798 he discovered chromium and its compounds and so named it because of their colours. He also discovered beryllium compounds, and isolated many organic substances (e.g. asparagine). He was much helped by the interest and influence of Fourcroy, whose assistant he was from 1783-91.

Vega, Georg, Baron von

Austrian mathematician

b. Mar. 23, 1754, Sagoritz, Carniola
d. Sep. 26, 1802, nr. Vienna

Vega studied mathematics at Laibach (Ljubljana), became a navigational engineer, joined the Artillery, and in 1787 was appointed professor of mathematics in the Bombardierkorps. He published the first edition of his *Logarithmische, trigonometrische und andere . . . Tafeln und Formeln* in 1783, and the second and more important edition in 1797, edited in 1839 and 1849 by Hulsse. In 1797 appeared Vega's *Logarithmisch-trigonometrisches Handbuch*, later edited by Hulsse and Bremiker (94th ed., 1935).

Vernier, Pierre

French technician

b. 1580, Ornans, nr. Besançon
d. Sept. 14, 1637, Ornans

Vernier spent most of his life in the service of the King of Spain in the Low Countries. In 1631 he invented the famous auxiliary scale to subdivide the divisions of an ordinary scale. This was one of the landmarks in the progress towards accurate measurement, and represented a considerable improvement on the nonius of the Portuguese mathematician Pedro Nunez (1492-1577).

Vernon-Harcourt, Augustus George

English chemist

b. Dec. 24, 1834, London

d. Aug. 23, 1919, Ryde, Isle of Wight

Educated at Oxford, Vernon-Harcourt became reader in chemistry there. He served on a commission to investigate London's gas supply, in the course of which he invented a standard lamp of ten candle-power using pentane as a fuel. This standard was replaced by a carbon filament electric lamp, and the international candle as a unit (1921), and in 1946 by the candela.

Very, Frank Washington

American astronomer

b. 1852, Salem, Mass.

d. Nov. 23, 1927, Westwood, Mass.

While he was Langley's assistant, from research with the latter's improved bolometer, Very came to the conclusion that the temperature of the moon's surface when the sun is overhead is about 212° F., rising to 356° F. later in the 'day'. Langley and he also studied the radiation of the firefly. He designed a recording measuring device for Fraunhofer lines, showed that the white nebulae are galaxies, and reaffirmed the presence of oxygen and water

vapour in the Martian atmosphere. In 1906 he became director of the Westwood Astrophysical observatory.

Vesalius, Andreas

Flemish anatomist

b. Dec. 31, 1514, Brussels

d. Oct. 15, 1564, Zante, Greece

The father of modern anatomy, Vesalius studied at Louvain and Paris, but left to become professor at Padua in 1537 as he did not agree with the teaching in Paris. He subsequently taught at Basle, Pisa and Bologna. In 1543 he published his famous book *De Humani Corporis Fabrica*, which became the foundation of modern biology. He was obliged to resort to 'body snatching' to obtain material for his researches and, compelled by the Inquisition to make a pilgrimage in 1564 in commutation of a death sentence passed on him for dissecting the human body, he died on the way back. He corrected 200 of Galen's mistaken doctrines and went near to making some great discoveries—for instance he recognised the valves in veins but failed to appreciate their true function. He was the first to maintain the brain and nervous system as the physical correlatives of personality, not the heart as Aristotle had stated, and paved the way for Harvey by denying the existence of pores between the ventricles of the heart. Vesalius' discoveries are too numerous for individual mention, but together they form the basis of modern human anatomy, and entitle him to be regarded as possibly the greatest anatomist of any age. The beautiful figures which form the more important part of his book were drawn by J. S. van Calcar, a pupil of Titian.

Vieta, Franciscus, or François Viète,

Seigneur de la Bigotière

French mathematician

b. 1540, Fontenay-le-Comte, Poitou

d. Dec. 13, 1603, Paris

After studying law Vieta became a privy councillor, and while a royal officer to Henry IV distinguished himself by solving an important Spanish cypher. He is remembered as the father of modern

algebra, and did much work on the solution of equations up to the fourth degree. Apart from the absence of the *equals* sign his notation is modern. He discovered the formula for the sine of a multiple angle and devised an infinite product for π .

Vinci, Leonardo, da

Italian artist and scientist

b. 1452, Vinci, nr. Florence

d. May 2, 1519, nr Amboise, Indre-et-Loire, France

Trained as an artist, Leonardo came near realising the Renaissance ideal of the all-round man, attaining almost equal eminence as artist, scientist, poet, engineer, architect, anatomist. Among his works the *Last Supper* (1498) and the *Monna Lisa* are household words. In 1482, after visiting the East and serving the Sultan of Cairo, he entered the service of the Duke of Milan, for whom he designed engineering as well as artistic work, and later attached himself to Cesare Borgia and the French royal house. Though his consummate achievement is artistic, his scientific work, often incomplete as it was, went far beyond anything of the period in ideas, and would have been even more valuable had he not lacked notation to express himself. He devised a system of hydraulic irrigation for the plains of Lombardy; and indeed may be said to have founded the study of hydraulics. His notes and drawings show conceptions of a flying machine, breech-loading and quick-firing guns, a parabolic compass and a tank. He also understood the significance of fossils and was the first to explain the phenomenon of 'earth-light' on the moon.

Virchow, Rudolf

German pathologist

b. Oct. 13, 1821, Schivelbein, Pomerania

d. Sep. 5, 1902, Berlin

After studying in Berlin, Virchow became professor of pathological anatomy first at Wurzburg and in 1856 in Berlin. A leading authority on hospital reform and sanitary science, his most famous work was his *Die Cellularpathologie* (1858), a development of Schwann's work in which

VIRTANEN

he stated the important doctrine that every morbid structure consists of cells derived from pre-existing cells. He made many contributions to histology and morbid anatomy, including work on tumours, phlebitis and leukaemia, and was also an active politician in opposition to Bismarck.

Virtanen, Artturi Ilmari

Finnish biochemist

b. Jan. 15, 1895, Helsinki

The son of an engine driver, Virtanen was educated at Helsinki and later studied at Zürich, Münster and Stockholm. After holding several technical appointments he became professor of biochemistry at Helsinki in 1939, and director of the Biochemical Institute. He elucidated the process of nitrogen fixation by root nodule bacteria of Leguminosae, and showed that higher orders can obtain complex substances from the soil. He developed a valuable method of preserving silage by treatment with dilute hydrochloric acid. His work on nutrition and the development of food resources gained for him the Nobel prize for chemistry in 1945.

Vogel, Hermann Carl

German astronomer

b. Apr. 3, 1841, Leipzig

d. Aug. 13, 1907, Potsdam

Educated at Leipzig, Vogel became assistant in the observatory and eventually director of the new astrophysical observatory at Potsdam in 1882. He is known as the discoverer of spectroscopic binaries.

Vogel, Hermann Wilhelm

German chemist

b. Mar. 16, 1834, Dobrilugk, Brandenburg

d. Dec. 17, 1898, Charlottenburg

Vogel was a teacher at the Gewerbeakademie, Berlin (1864), and later at the Technische Hochschule. He invented (1873) the orthochromatic photographic plate by adding dyes to the emulsion. He designed a photometer, studied spectroscopic photography, and wrote two textbooks on the chemistry of photography.

Volta, Count Alessandro

Italian physicist

b. Feb. 18, 1745, Como

d. Mar. 5, 1827, Como

The professor of natural philosophy at Pavia (1774-1804), Volta developed the theory of current electricity and discovered the decomposition of water by electricity. He was the inventor of the voltaic pile, the electrophorus and an electroscope, and his name is perpetuated in the unit of electrical pressure. He was awarded the Copley medal in 1791, and was summoned to display his discoveries to Napoleon.

Voronoff, Serge

Russian physiologist

b. 1866, Voronezh; *d.* 1951, Lausanne

Educated in Paris, Voronoff became chief surgeon in the Russian hospital and, after other appointments, director of experimental surgery of the Station Physiologique du Collège de France. Famous for his work on animal gland grafting into the human body (following the discoveries of Brown-Séquard) he brought forward a theory connecting gland secretions with senility. This is dealt with in his book *The Study of Old Age and My Method of Rejuvenation*.

Vries, Hugo de. *See de Vries*

W

Waage, Peter

Norwegian chemist

b. 1833, Flekkefjord, Vest-Agder
d. 1900

Educated at Christiania (Oslo). Waage became professor of chemistry there in 1862. He collaborated with Guldberg (q.v.) from 1864 to 1867 in the presentation of the law of mass action.

Waals, Johannes Diderik van der Dutch physicist

b. Nov. 23, 1837, Leyden

d. Mar. 9, 1923, Amsterdam

Educated at Leyden, van der Waals became professor of physics at Amsterdam in 1877 and was awarded the Nobel prize for physics in 1910. He was the discoverer of an important equation (named after him) which expresses the relation between pressure and volume of a substance in liquid as well as in a gaseous state (1873). He investigated electrolytic dissociation, capillarity as a thermodynamic phenomenon, and intermolecular attraction (van der Waal's forces).

Wagner-Jauregg, Julius

Austrian neurologist and psychiatrist

b. Mar. 7, 1857, Wels, Austria

d. Sept. 27, 1940, Vienna

Educated in Vienna, Wagner-Jauregg became professor of psychiatry there (1893-1928) after a few years at Graz. He worked on the thyroid gland and its connection with cretinism and was noted for his treatment of general paralysis by infection with malaria. For this work he was awarded the Nobel prize for medicine in 1927.

Waksman, Selman Abraham

American biochemist

b. July 2, 1888, Priluka, Kiev, Russia

Going to the U.S.A. in 1910, Waksman became an American citizen in 1916; he

is an expert on soil microbiology. In 1930 he became professor in this subject at Rutgers University, going later to the New Brunswick Agricultural Station and then to the Woods Hole Oceanographic Institute (1930) as marine bacteriologist. With Woodruff in 1941 he isolated actinomycin A, a more powerful antibacterial than penicillin. Unfortunately it is highly poisonous. In 1944 he and his colleagues isolated streptomycin from the actinomycete *Streptomyces griseus*. It has proved valuable in the treatment of tularaemia, influenzal meningitis and tuberculosis. His work has contributed greatly to the knowledge and isolation of antibiotics generally. In 1952 he was awarded the Nobel prize for physiology and medicine.

Walden, Paul

Russian chemist

b. July 14, 1863, Livland

Educated at Riga, Leipzig and Munich, Walden went to the first named as professor and then to St. Petersburg (1910) and Riga again (1918). He finally became professor of physical chemistry at Rostock in 1919. He carried out much research on electrical conductivity and dissociation and is noted for his discovery of the bimolecular Walden inversion. This is a phenomenon connected with optical isomerism of carbon. He has studied also electrical conductivity in liquids.

Walker, Sir James

Scottish chemist

b. Apr. 6, 1863, Dundee

d. May 6, 1935, Edinburgh

Though trained in commerce, Walker turned his attention to chemistry and studied at Edinburgh, Munich and Leipzig. He became professor of chemistry at Dundee and later at Edinburgh, and was elected F.R.S. in 1900. He conducted

WALKER

many researches in organic chemistry on such subjects as hydrolysis, ionisation constants and amphoteric electrolytes.

Walker, John

English chemist

b. 1781, Stöckton-on-Tees

d. May 1, 1859, Stockton

Turning against surgery through a dislike of operations, Walker became a pharmaceutical chemist. He is famous as the inventor in 1826 of the first friction match which he called the Friction Light and sold at the rate of 1/- for fifty. The mixture used was antimony sulphide, potassium chlorate, gum and sulphur.

Wallace, Alfred Russel

English biologist

b. Jan. 8, 1823, Usk, Monmouthshire

d. Nov. 7, 1913, Broadstone, Dorset

After spending many years travelling and collecting data on animal life, Wallace was led towards the idea of natural selection and in fact he wrote an essay in which he anticipated the origin of species. His paper was published jointly with one by Darwin in 1858. He is famous for the support which he gave to the theory of evolution, but he insisted to a greater degree than Darwin on the survival of the fittest as the principal factor in the struggle for existence. He postulated Wallace's line in connection with the geographical distribution of animals. He was a spiritualist in later life and one of his many books explained his reasons for acceptance of this doctrine. Nevertheless he strongly denied the possibility of any spiritual evolution comparable to the physical. He was not in favour of vaccination.

Wallach, Otto

German organic chemist

b. Mar. 27, 1847, Königsberg

d. Feb. 22, 1931, Göttingen

Educated at Göttingen and Berlin, and a pupil of Kékulé, Wallach worked for most of his early life at Bonn where he became professor of chemistry. He finally went to Göttingen (1889-1915). In 1910 he was awarded the Nobel prize in chemistry for

his work on the essential oils and the terpenes.

Waller, Augustus Volney

English physiologist

b. Dec. 21, 1816, Faversham, Kent

d. Sept. 18, 1870, Geneva

Of French extraction, Waller was educated in Paris and Bonn. He specialised in neurology and in 1850 brought out the Wallerian theory of degeneration which has enabled physiologists to trace the course of nerve fibres experimentally.

Wallis, John

English mathematician

b. Nov. 23, 1616, Ashford, Kent

d. Oct. 28, 1703, Oxford

Educated at Cambridge for the Church, Wallis became Savilian professor of geometry at Oxford. He was an early fellow of the Royal Society, and wrote the first mathematical treatise on the tides, as well as other books on arithmetic and related subjects. He introduced the symbol ∞ for infinity. His *Arithmetica Infinitorum* (1655) prepared the way for the integral and differential calculus and the binomial theorem by the introduction of an arithmetical formulation of limit. He was a founder of the Royal Society, was secretary to the Westminster Assembly, sided with Parliament but favoured the Restoration, opposed Hobbes on the quadrature of the circle, and edited Greek mathematical texts.

Walter, Philipp

Polish chemist

b. 1810

d. 1847

With Pelletier in 1836 Walter obtained toluene by the distillation of pipe resin.

Walton, Ernest Thomas Sinton

Irish physicist

b. Oct. 6, 1903, Dungarvan, Waterford

Walton became professor of natural and experimental philosophy at Dublin in 1946. With Cockcroft in 1932 he succeeded in disintegrating lithium by means of proton bombardment; they were awarded the Nobel physics prize in 1951.

Warburg, Otto Heinrich

German-physiological chemist

b. Oct. 8, 1883, Freiburg, Baden

Educated at Berlin and Heidelberg, and working at the Kaiser Wilhelm Institute for Biology, Warburg has done important work on the chemistry of respiration and on cancer. He gained the Nobel prize for medicine in 1931 for his research on enzymes.

Waterston, John James

Scottish physicist

b. 1811, Edinburgh

d. June 18, 1883, Edinburgh

Educated in Edinburgh in engineering, physics, chemistry and surgery, Waterston practised as an engineer and teacher in London and Bombay before returning to Edinburgh to devote the rest of his life to physical experiment. He developed a kinetic theory of gases in 1845 which he sent to the Royal Society. This was not printed, however, until 1892 when Lord Rayleigh found it in the archives. In the meantime a similar theory had been produced by Clausius and others though, as Lord Rayleigh pointed out, the progress of research in heat had been delayed by ten or fifteen years. His *Thoughts on the Mental Functions*, a remarkable essay on physiological psychology, was similarly in advance of his day and passed unnoticed. He wrote also on astronomy. One day he disappeared from his home in Edinburgh and was never seen or heard of again.

Watson, John Broadus

American psychologist

b. Jan. 9, 1878, Greenville, S. C.

Educated at Furman and Chicago Universities, Watson worked at the latter before going to the Johns Hopkins University as professor of experimental and comparative psychology (1908-21). He is famous for his theories of behaviourism, being one of its leading exponents, and published *Behavior—An Introduction to Comparative Psychology* (1914), one of the fundamental works on this aspect of psychology. He opposed the appeal to conscious and unconscious mental activity in introspection, and substituted an objec-

tive description in terms of physiological responses to stimuli (behaviour). His views, reiterated in subsequent books, have been widely accepted in attenuated form. He was editor (1908-15) of the *Psychological Review*, and from 1915 of the *Journal of Experimental Psychology*.

Watson, Sir William

English physician and electrician

b. Apr. 3, 1715, Smithfield, London

d. May 10, 1787, London

A London apothecary, Watson was one of the earliest experimenters on electricity. As well as working on electrostatics, he was the first to investigate the passage of electricity through a rarefied gas, and discovered the increase in conductivity which resulted. His air-pump was not efficient enough to produce a really high vacuum. He introduced the Linnaean system to Britain and gained the Copley medal in 1745 for his electrical work.

Watson-Watt, Sir Robert Alexander

Scottish physicist

b. Apr. 13, 1892, Brechin, Angus

Educated at Dundee and St. Andrews,



SIR ROBERT WATSON-WATT received the American Medal of Merit from President Truman in 1946.

WATT

Watson-Watt entered the meteorological office and later the Department of Scientific and Industrial Research and the radio section of the National Physical Laboratory. He has been connected with the Ministry of Aircraft Production since 1942. He is noted as one of the team of British scientists responsible for the development of radar during the last war.

Watt, James

Scottish engineer

b. Jan. 19, 1736, (o.s.) Greenock

d. Aug. 19, 1819, Handsworth, nr. Birmingham

The son of an unsuccessful merchant, Watt was apprenticed to an instrument maker in London and returned to Glasgow in the same capacity. He became friendly with Joseph Black, the discoverer of latent heat, and this led to his considering steam as a motive force. After some experiments with a Papin's Digester he hit upon the Newcomen steam-engine, a model of which was sent to him to repair. He at once saw how it could be improved, and his invention of the separate condenser and other modifications such as the air-pump, cylinder steam jacket, centrifugal governor and the steam indicator made the steam engine once for all a commercial success. Among his other patents were the sun-and-planet motion, expansion principle, the double engine, and parallel motion. Watt claimed to be a discoverer of the composition of water at about the same time as Cavendish. The unit of electric power is named after him. With Boulton he founded the Soho Engineering Works (1775), and the partners introduced the term horsepower.

Watts, James Winston

American neuro-surgeon

b. Jan. 19, 1904, Lynchburg, Va.

Educated at Virginia, Watts occupied many medical posts at American universities and hospitals. He is famous for his brain surgery, and with Freeman has developed the operation known as pre-frontal lobotomy. This involves cutting the connection between the prefrontal lobes and the thalamus, and has been

the means of alleviating many cases of anxiety neurosis and similar mental disorders. (See also A. E. Moniz.)

Weber, Ernst Heinrich

German physiologist and anatomist

b. June 24, 1795, Wittenberg

d. Jan. 26, 1878, Leipzig

Elder brother of Wilhelm, Ernst Weber conducted researches on the organs of sense, with special emphasis on the ear. He studied acoustics, and with his brother published the basic *Wellenlehre* (1825). The law which he formulated and which bears his name states that the least perceptible increase in stimulus (intensity of sound) bears a constant ratio to the total stimulus. The implications of this law are not now accepted.

Weber, Wilhelm Eduard

German physicist

b. Oct. 24, 1804, Wittenberg, Meck.

d. June 23, 1891, Göttingen

Educated at Halle and Göttingen, Weber became professor of physics at the latter university (1831) and at Leipzig (1843-49). At one time he was expelled from his professorship for political reasons. He played a prominent part in the development of electrical science with particular reference to the establishment of a system of absolute electrical units, which he modelled on Gauss' magnetic units. With Gauss he studied terrestrial magnetism and used Bunsen's ice calorimeter to find the specific heat of a diamond. He foreshadowed many later ideas, notably those of Maxwell. The practical unit of magnetic flux (10^8 c. g. s. units) has been sometimes named a weber.

Wegener, Alfred Lothar

German geologist

b. Jan. 11, 1880, Berlin

d. Nov., 1930, Greenland

After study at Berlin, Heidelberg and Innsbruck, Wegener became professor of meteorology at Hamburg in 1919 and at Graz in 1924. He died on his fourth scientific expedition to Greenland. In 1912 he brought forward the idea of continental drift—the gradual drift away

of continents from a primitive single land mass—which, though over-stressed and badly presented, is now accepted as a working hypothesis. A similar idea had been proposed by F. B. Taylor in 1910. He published this theory in *Die Entstehung der Kontinente und Ozeane* (1915) and other researches in *Thermodynamik der Atmosphäre* (1911).

Weierstrass, Karl

German mathematician

b. Oct. 31, 1815, Ostenfelde

d. Feb. 19, 1897, Berlin

After studying at Bonn and Münster, Weierstrass became professor of mathematics at Berlin subsequent to holding previous academic appointments. He is notable for his original work on the theory of functions, e.g. Abelian, elliptic and analytic, and on the calculus of variations. His work on complex variables was particularly outstanding. His main work was *Abhandlungen aus der Funktionentheorie* (1886).

Weismann, August

German biologist

b. Jan. 17, 1834, Frankfort-on-Main

d. Nov. 6, 1914, Freiburg in Baden

A pupil of Leuckart at Giessen, Weismann became professor of zoology at Freiburg (1866-1912). He suffered in middle life from eye trouble which limited his experimental work, but his theoretical work on heredity has placed him in the first rank of biologists. He insisted on the non-inheritance of acquired characters and devised the idea of the germ-plasm, that part of man which is actually passed on. He wrote several books, of which *Das Keimplasma* (1892) outlined his theory of heredity due to variation in germ-plasm.

Wells, Horace

American dentist

b. Jan. 21, 1815, Hartford, Vt.

d. Jan. 24, 1848, New York

One of the first to appreciate the value of nitrous oxide as an anaesthetic, Wells persuaded a friend, Dr. Riggs, to extract one of his teeth under this gas, and on its success attempted to introduce its use into general practice. Owing to insufficient

knowledge of its application, however, it was a failure and he gave up dentistry, eventually committing suicide in prison where he was facing a charge of vitriol throwing.

Wells, Roger Clark

American chemist

b. Oct. 24, 1877, Peterboro, N.Y.

Educated at Harvard, Wells became assistant there in 1902. After several academic appointments he eventually became chief chemist of the U.S. Geological Survey in 1930. He carried out many chemical analyses of radioactive minerals, and has done research on sodium compounds.

Welsbach, Carl Auer, Baron von

Austrian chemist

b. Sep. 1, 1858, Vienna

d. Aug. 4, 1929, Treibach

Educated at Vienna and Heidelberg, von Welsbach did research work on the rare earths. He showed that the oxide didymia was a compound of two other oxides of elements which were named praseodymium and neodymium. Auer (his original name) is best known however for the use he made of the rare earths in his invention of the incandescent mantle, which was first called the 'auerlicht.'

Wenzel, Carl Friedrich

German chemist and metallurgist

b. 1740, Dresden

d. Feb. 26, 1793, Freiberg

Wenzel worked on the rate of solution of metals in acids. In 1777 he forecast the law of mass action by his discovery that the rate of solution of a metal is proportional to the concentration of the acid.

Werner, Abraham Gottlob

German geologist

b. Sept. 25, 1750, Wehrau, Upper Lusatia, Saxony

d. June 30, 1817, Dresden

After studying mining at Freiberg and law and mineralogy at Leipzig, Werner was from 1775 to 1817 professor of mining and a world-renowned teacher at Freiberg in Saxony. He taught that granite was a sedimentary rock, which was disproved

WERNER

later by James Hutton. He was an advocate of neptunism and known for his work in classification. His classification of the rocks of the Harz mountains established historical classification on a sound basis, and his methods in mining geology were widely influential. After a long period of controversy his contention that volcanoes were of late occurrence and that rocks were precipitated in water was discredited. (See J. Hutton.)

Werner, Alfred

Swiss chemist

b. Dec. 12, 1866, Mulhausen, Alsace

d. Nov. 15, 1919, Zürich

Educated at Zürich, Werner worked with Berthelot in Paris for a time before returning to Zürich as professor of chemistry in 1893. He is famous for his co-ordination theory of valency (1893) which, though subject to later revision, was of great value and led to increased knowledge of isomerism and complex salts. He was awarded the Nobel prize for chemistry in 1913. His *Lehrbuch der Stereochemie* appeared in 1904.

Westinghouse, George

American inventor

b. Oct. 6, 1846, Central Bridge, N.Y.

d. Mar. 12, 1914, New York

After serving in the Union Army, Westinghouse later joined the navy as an engineer. He is noted as the inventor of the automatic air-brake which has been adopted by railways throughout the world. He later did work on electrical transmission. He founded companies to manufacture his railway and electrical devices, the most important being the Westinghouse Electric Co. (1886).

Wheatstone, Sir Charles

English physicist

b. Feb. 1802, Gloucester

d. Oct. 19, 1875, Paris

After beginning as a maker of musical instruments, Wheatstone became known to science through his experiments on sound. In 1834 he became professor of experimental philosophy at King's College, London, and in 1836 was elected F.R.S.

In 1829 he invented the concertina and stereoscope, and in 1837 with Cooke he took out the first patent for the electric telegraph. He introduced the word *microphone* for a sound magnifier which he invented, but it was not an electrical instrument. He measured the velocity of electricity in a conductor and introduced the rotating mirror method for the examination of vibrating bodies. *Wheatstone's bridge*, an instrument for the comparison of electrical resistances, was constructed from an idea which he got from S. Hunter Christie.

Whipple, George Hoyt

American pathologist

b. Aug. 28, 1878, Ashland, N.H.

Educated at Yale and the Johns Hopkins University, Whipple worked at the latter as pathologist before going to California and later to Rochester as professor of pathology. His work with Minot and Murphy on anaemia and liver treatment was outstanding. In 1934 he shared the Nobel prize for medicine with his co-workers.

Whitehead, Alfred North

English mathematician and philosopher

b. Feb. 15, 1861, Isle of Thanet

d. Dec. 30, 1947, Cambridge, Mass.

Educated at Cambridge, and elected F.R.S. in 1903, after holding academic posts in mathematics at Cambridge and London, Whitehead went to Harvard in 1924 as professor of philosophy, retiring in 1936. He was one of the ablest mathematicians of his time, and collaborated with Bertrand Russell in the production of *Principia Mathematica* in addition to writing works on philosophy and mathematics, such as *Adventure of Ideas* (1933), *Nature and Life* (1934), *Modes of Thought* (1938) and *Concept of Nature* (1920). He was one of the most influential and original, if one of the most involved, thinkers of his generation. In his early work he was one of the founders of modern mathematical logic, but later his thought was increasingly directed to physical-philosophical and metaphysical problems. The most elaborate exposition of his 'philosophy' of

organism' is contained in his Gifford lectures *Process and Reality* (1929), 'a transformation of some of the main doctrines of Absolute Idealism on to a realistic basis'.

Whitehead, Robert

English inventor

b. Jan. 3, 1823, Bolton-le-Moors, Lancs.

d. Nov. 14, 1905, Shrivenham, Berks.

Trained as an engineer in Manchester, Whitehead worked in Milan and Trieste. He invented the torpedo in 1866 and, buying the Austrian plant at Fiume where he worked, converted it for the production of his invention. He later acquired Obry's invention of the gyroscope (1896) and incorporated it in his torpedoes to increase precision of aim.

Whitney, Eli

American inventor

b. Dec. 8, 1765, Westboro, Mass.

d. Jan. 8, 1825, New Haven, Conn.

Educated at Yale, where his expenses were paid largely from the results of his early inventions, Whitney was led to invent the gin (1793) by a chance suggestion of a cotton owner with whom he was staying. This machine was of immense use in the gathering of cotton as it performed the separation of seed from cotton. Like many other inventors, he had difficulty with his patent rights. He next turned to the manufacture of fire-arms, being one of the earliest to introduce division of labour and standardisation of parts.

Whittle, Air Commodore Sir Frank

English inventor

b. June 1, 1907

Educated at Cambridge, Whittle passed from the R.A.F. to research work on jet propulsion, and from 1946 to 1948 was technical adviser on engine design to the government. Noted for his invention of the jet engine for aircraft and his work thereon, he has been the recipient of many academic honours and is a fellow of the Royal Society.

Whitworth, Sir Joseph, Bart.

English engineer

b. Dec. 21, 1803, Stockport, Lancs.

d. Jan. 22, 1887, Monte Carlo

Trained in machine-manufacturing and tool-making, Whitworth became famous for his standardisation of screw threads and for his work on the development of machine tools. He later was employed by the government in designing new rifles and guns and produced the well-known gun which bears his name. The Whitworth scholarships for industry were founded by him, and he gave large sums towards charitable and educational objects.

Wieland, Heinrich Otto

German organic chemist

b. June 4, 1877, Pforzheim, Baden

After studying at Munich, Berlin and Stuttgart, Wieland went to the first-named as professor of organic chemistry, and after a four year term in a similar office at Freiburg returned to Munich in 1925. He was awarded the Nobel prize for chemistry in 1927 for outstanding work on the bile acids, organic radicals, nitrogen compounds, etc. He studied morphine and the alkaloids of *Strychnos*, and oxidation processes.



SIR FRANK WHITTLE

WIEN

Wien, Max Carl

German physicist

b. Dec. 25, 1866, Königsberg

d. Feb. 24, 1938, Jena

After being Röntgen's assistant at Würzburg, Wien, a cousin of Wilhelm Wien, became professor of physics at Danzig (1904) and at Jena (1911-35). He conducted important researches in high-frequency electromagnetic waves, impulse excitation and the behaviour of electrolytes in high voltage gradients.

Wien, Wilhelm

German physicist

b. Jan. 13, 1864, Gaffken, E. Prussia

d. Aug. 31, 1928, Munich

Educated at Göttingen, Heidelberg and Berlin, Wien was assistant to Helmholtz before becoming professor at Aix-la-Chapelle and later at Giessen, Würzburg and Munich (1920). An authority on the radiation from black bodies, he was awarded the Nobel prize for physics in 1911 for his discovery of two laws, named after him. His displacement law states that the product of the wavelength for maximum energy density and the absolute temperature is constant. He was the author of several books on the subject.

Williamson, Alexander William

English chemist

b. May 1, 1824, Wandsworth, London

d. May 6, 1904, Hindhead, Surrey

After studying medicine at Heidelberg, Williamson turned to chemistry and continued at Giessen under Liebig. He became professor of chemistry at University College, London (1849-87), and was elected F.R.S. in 1855. His researches covered a wide range, and his organic studies of the alcohols and ethers were of great importance. In the synthesis of methyl ethyl ether he broke new ground and he also synthesised ethylene glycol (with Kay). He was the first to suggest the intermediate compound theory of catalysis

Williamson, William Crawford

English botanist

b. Nov. 24, 1816, Scarborough

d. June 23, 1895, Clapham, London

Trained in medicine, Williamson became first professor of natural history and physiology at Owens College, Manchester (1851-92). He was elected F.R.S. in 1854. An associate of William Smith, he was the first to show the importance of the plant life forms in coal. This was between 1858 and 1882 and it was not until the latter date that his work began to be appreciated. He was one of the founders of this new branch of biology, known as palaeobotany.

Willis, Thomas

English physician

b. Jan. 27, 1621, Great Bedwin

d. Nov. 11, 1675, London

After studying medicine at Oxford, and serving as a Royalist, Willis became in 1660 Sedleian professor of natural philosophy at Oxford, and was a founder-member of the Royal Society. In 1666 he began a lucrative practice in London. He made important researches on the anatomy of the brain, discovering the arteries at its base (circle of Willis), the eleventh cranial nerves, the functions of corpora striata, and the optic thalamus. The classic *Cerebri anatome nervorumque descriptio et usus*, illustrated by Sir Christopher Wren, appeared in 1664, and his *Pharmaceutice rationalis*, in which he described the presence of sugar in diabetic urine, in 1674. He realised the part played by combustion in body heat, described puerperal fever, myasthenia gravis, and the paracosis of Willis (the condition of acuter hearing through a noise).

Willstätter, Richard

German chemist

b. Aug. 13, 1872, Karlsruhe

d. Aug. 3, 1942, Locarno, Switzerland

Professor of chemistry in Berlin (1912-16) and Munich (1916-25), Willstätter investigated alkaloids and their derivatives, for example cocaine, tropine, atropine, etc. He synthesised many organic substances such as lecithin (1904) and chlorophyll (1906) and investigated the colouring matter of flowers, the carbon dioxide assimilation of plants, and enzymes. He

was awarded the Nobel prize for chemistry in 1915 for his work on plant pigments.

Wilson, Charles Thomson Rees
Scottish physicist

b. Feb. 14, 1869, Glencorse, nr. Edinburgh

Educated at Manchester and Cambridge
Wilson was professor of natural philosophy at the latter university from 1925 to 1934, sharing with Compton the Nobel prize for physics in 1927. Famous for his work on ionisation, he discovered that even in the absence of dust, ionised particles can act as nuclei for the formation of water drops. This led him to the important cloud-chamber method of studying ionised particles, which has proved essential in atomic studies. *On the Cloud Method of Making Visible Ions and the Tracks of Ionising Particles* (Les Prix Nobels, Stockholm, 1927) gives an account of his method.

Windaus, Adolf
German chemist

b. Dec. 25, 1876, Berlin

Educated at Freiburg, and Berlin under Emil Fischer, Windaus worked mainly at the former university before becoming professor of applied medical chemistry at Innsbruck and later at Göttingen. In 1928 he gained the Nobel prize for chemistry for his work on sterols, notably his discovery that ultraviolet light activates ergosterol and gives Vitamin D₂. He was an authority on cardiac poisons.

Winkler, Clemens Alexander
German chemist

b. Dec. 26, 1838, Freiberg

d. Oct. 8, 1904, Dresden

Educated at Freiberg, Winkler became professor of chemistry there. In 1886 he discovered the element germanium and investigated its properties. He made important advances in the technique of the analysis of gases.

Winton, Will McClain
American geologist

b. 1885, Santa Rosa, Fla.

Educated at Vanderbilt, Winton held posts

as professor of biology before becoming professor of geology in 1930 at Texas. He developed a method of measuring the age of thick layers of sediments by studying the annual growth rings of bivalve shells buried in them.

Wislicenus, Johannes Adolf
German chemist

b. June 24, 1835, Klein-Eichstädt, Thuringia

d. Dec. 6, 1902, Leipzig

Having gone to America as a young man, Wislicenus worked at Harvard for a time. Returning to Zürich he became professor of chemistry there, and later at Würzburg and Leipzig. He is noted for his work on the lactic acids, and in particular for his discoveries in the study of the geometrical isomerism (the existence of identical formulae with differing chemical properties) of organic compounds.

Withering, William
English physician

b. Mar., 1741, Wellington, Shropshire

d. Oct. 6, 1799, Isle of Wight

Educated at Edinburgh, Withering practised in Birmingham. He wrote a book on *British Flora* and was the first to see the connection between dropsy and heart disease. He introduced digitalis as a drug for cardiac disease (*An Account of the Foxglove*, 1785).

Wöhler, Friedrich
German chemist

b. July 31, 1800, Eschersheim, nr. Frankfurt-on-Main

d. Sept. 23, 1882, Göttingen

After studying under Gmelin and Berzelius Wöhler eventually became professor of chemistry at Göttingen in 1836. He was closely associated with Liebig in his work on the benzoyl radical, but was of a less argumentative disposition. He did a great deal of work in organic chemistry, and also on the rare metals, isolating aluminium in 1827 and beryllium in the following year. He discovered calcium carbide and the preparation of acetylene from it, evolved the generally used method for the preparation of phosphorus, and in

WOLF

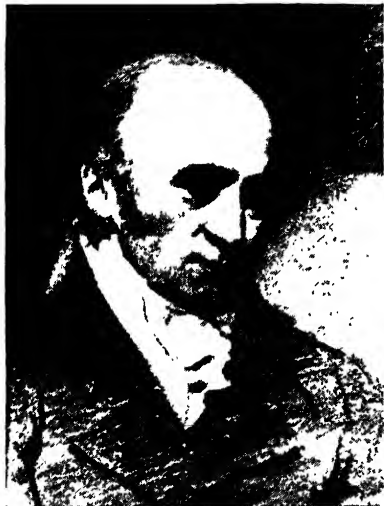
1828, he synthesised urea from ammonium cyanate. This, the first synthesis of an organic compound, exploded the vitalistic theory that organic compounds could be produced only by living organisms.

Wolf, Máximilian Franz Joseph Cornelius
German astronomer

b. June 21, 1863, Heidelberg

d. Mar. 10, 1932, Heidelberg

Educated at Heidelberg and Stockholm, Wolf invented the photographic method of discovering asteroids which enabled him and his assistants to add hundreds to the known total. He became professor of astronomy at Heidelberg and director of the Königstuhl astrophysical observatory there in 1896. He discovered many new 'photographic' nebulae, for example the North America Nebula. With Barnard he was the first to appreciate the presence of 'dark' nebulae in the sky. He discovered a comet (1883) with a period of seven years.



WILLIAM HYDE WOLLASTON isolated palladium and advertised it for sale in an anonymous leaflet in the window of a Piccadilly goldsmith. It was bought by the French chemist Chenevix, who denounced it as a fraudulent platinum amalgam. Wollaston subsequently disclosed its true nature.

Wollaston, William Hyde

English chemist and physicist

b. Apr. 6, 1766, East Dereham, Norfolk

d. Dec. 22, 1828, London

Educated at Charterhouse and Cambridge in medicine, for a time Wollaston practised at Bury St. Edmunds. He was elected F.R.S. in 1794. He developed a method of making platinum malleable and succeeded in producing a platinum wire 1/30,000 inch in diameter. This process earned him sufficient to retire from medicine and to devote himself entirely to research. In 1801 he proved experimentally that frictional and current electricity are the same, and in the next year he investigated emission and absorption spectra and discovered the lines in the solar spectrum. In 1803 he discovered palladium, and in 1804 rhodium. His inventions include a camera lucida, an optical instrument which produces a reflected picture, and a cryophorus, an instrument which shows the fall in temperature of water on evaporation. He also invented the reflecting goniometer for measuring angles of crystals, and a double image prism to split a single ray into two divergent rays. Another invention of his was a lens consisting of two glass hemispheres cemented with their plane sides together and a stop in between, thus avoiding aberration. This lens carries his name.

Wood, Robert Williams

American physicist

b. May 2, 1868, Concord, Mass.

Educated at Harvard, Chicago, Berlin and other universities, Wood became professor of experimental physics at the Johns Hopkins University (1901-38). He obtained some fine photographs of sound waves in air showing reflection from surfaces of various shapes. He constructed a zone plate which could be used in place of a lens as the object glass of a telescope, and he invented a diffraction process of colour photography. He was the author of *Physical Optics* (1905), and did research on high-frequency sound waves and their physiological effect.

Wright, Sir Almroth Edward

English bacteriologist

b. Aug. 10, 1861, Middleton Tyas, Yorks.

d. Apr. 30, 1947

Educated at Dublin, Leipzig, Strasbourg and Marburg, Wright held many important posts in pathology and medicine before becoming professor of experimental pathology in the University of London. He became a fellow of the Royal Society in 1906. His main work lay in the field of parasitic diseases, and he was responsible for the introduction of anti-typhoid inoculation and for the preparation of many vaccines. He proved the presence in the blood of opsonin which enhances the phagocytic properties of leucocytes.

Wright, Wilbur

American inventor

b. Apr. 16, 1867, nr. Millville, Ind.

d. May 30, 1912, Dayton, Ohio

After a somewhat sketchy education, Wilbur Wright and his brother Orville (*b.* Aug. 19, 1871; *d.* Jan. 30, 1948) opened a bicycle shop. Their interest in heavier-than-air flight was aroused by reading of a glider accident (1898) and their first glider was built in 1900. They then turned to experiments with motor-power, and their first successful machine, tested on Dec. 17, 1903 at Kitty Hawk, N.C., weighed 750 pounds, including pilot, and was driven by a 12 horsepower 4-cylinder engine. It flew for 59 seconds at 30 m.p.h., and travelled 852 feet. There was little public interest, but they rapidly improved their machines, and in 1908 were well received in Paris, where they won the Michelin trophy. In 1909 they formed a production company, and in the same year the U.S. Government accepted their aeroplane for army use. After some struggles over patent infringements, the company prospered, and Wilbur continued president till his death. He was succeeded by his brother, who in 1915 sold his interests to devote himself to research.

Wróblewski, Zygmunt Florenty von

Polish physicist

b. Oct. 28, 1845, Grodno

d. Apr. 19, 1888, Cracow

Professor of physics at the university of Cracow, in 1885 Wróblewski was the first to liquefy air on a large scale, and with Olszewski at Cracow he liquefied nitrogen, oxygen, and carbon monoxide.

Wunderlich, Carl August

German physician

b. Aug. 4, 1815, Sulz-on-Neckar

d. Sept. 25, 1877, Leipzig

Professor of medicine at Leipzig, Wunderlich was the first to appreciate that fever (high temperature) is only a symptom and not a disease, and introduced the temperature chart into hospitals. He used a clinical thermometer a foot long which took twenty minutes to register the temperature.

Wundt, Wilhelm Max

German physiologist and psychologist

b. Aug. 16, 1832, Neckarau, Baden

d. Aug. 31, 1920, Grossbothen, nr. Leipzig

Professor successively at Heidelberg, Zürich and Leipzig (1874-1917), Wundt is remembered as the founder at Leipzig of the first laboratory for experimental psychology (1879). His view of psychology as an introspective study, consisting of sensations, images, and feelings, did not long command assent, but his experimental method remains a contribution of historical importance. He wrote a number of works on physiology, psychology and philosophy.

Wurtz, Charles Adolphe

French chemist

b. Nov. 26, 1817, Wolfisheim, nr. Strasbourg

d. May 10, 1884, Paris

Trained first in medicine and then in chemistry, Wurtz became professor of chemistry at the Sorbonne in 1875. He is famous for his discovery of methyl and ethylamine and for the method of synthesis of hydrocarbons by the reaction of alkyl halides with sodium (Wurtz reaction). In work on the oxides of phosphorus in 1846 he discovered phosphorus oxychloride POCl_3 . In 1856 he discovered glycol; and he worked on the aliphatic amines.

Y

Yersin, Alexandre Émile John

Swiss-French bacteriologist

b. Sept. 22, 1863, Rougemont, Switz.

d. Mar. 2, 1943, Ukatrang, Indo-China

Educated at Lausanne, Marburg and Paris, Yersin worked with Roux at the Pasteur Institute on diphtheria antitoxin and then in China, where he also carried out some exploration. He discovered the plague bacillus in Hong Kong (1894) at the same time as Kitasato, and later prepared a serum for it, founding two Pasteur Institutes in China. He introduced the rubber tree into Indo-China.

Young, Thomas

English physicist and physician

b. June 13, 1773, Milverton, Somerset

d. May 10, 1829, London

After being elected F.R.S. at the age of twenty-one for his discovery of the effect of the ciliary muscle on the shape of the eye-lens (the process of accommodation), Young became physician to St. George's Hospital. A boy prodigy, skilled in modern languages and literature as well as in science, he had been trained as a doctor at Edinburgh, Göttingen and Cambridge. He was, however, too honest in his opinions to be successful, as he stated that a medical diagnosis is only a balance of probabilities. He propounded a theory of colour-vision, later elaborated by Helmholtz, which stated that a limited number of receptors (three) in the retina vibrated in the natural frequency of the three main colours, red, yellow and blue. In 1802 he joined Davy at the Royal

Institution as professor of natural philosophy. He discovered the interference of light and is famed for his researches on the laws governing this phenomenon which did much to substantiate the wave theory. His versatility was exemplified in his being in later life responsible for the interpretation of the inscriptions on the Rosetta Stone, secretary to the board of longitude and superintendent of the Nautical Almanac.

Yukawa, Hideki

Japanese physicist

b. 1907

After teaching at Kyoto and Osaka Universities, Yukawa left Japan for the U.S.A. in 1948. He worked at Princeton, and was subsequently appointed visiting professor of theoretical physics at Columbia University, New York. In 1935, while a lecturer at Osaka, he predicted the existence of a particle some hundreds of times heavier than the electron (the meson), experimentally verified in 1938 by Anderson and Neddermeyer. Yukawa's theory of nuclear forces, however, postulated a particle with slightly different characteristics, and in 1947 Powell demonstrated the existence of a short-lived π -meson, showing affinities to protons and neutrons, which exactly confirmed Yukawa's hypothesis. For this and subsequent work on the theory of the nuclear forces and on fundamental quantum theory, he was made Nobel laureate for physics in 1949, the first Japanese to be so honoured. He has now returned to Japan.

Z

Zeeman, Pieter

Dutch physicist

b. May 25, 1865, Zonnemaire

d. Oct. 9, 1943, Amsterdam

After studying at Leyden, and being assistant there, Zeeman became professor of physics at Amsterdam (1900). An authority on magneto-optics, he was the discoverer with Lorentz in 1896 of the fact that when a ray of light from a source placed in a magnetic field is examined spectroscopically the spectral line is widened or in some cases doubled. This is known as the Zeeman effect. He shared with Lorentz the Nobel prize for physics in 1902 and was an F.R.S.

Zeno of Elea

Greek philosopher

c. 450 B.C.

A follower of Parmenides and his doctrine of no-change, Zeno is remembered none too charitably by mathematicians as the formulator of four well-known paradoxes which flouted mathematical reasoning for some 2,000 years. *Achilles and the Tortoise*, the second of these, maintains that the 'fleet-footed Achilles' can never overtake a tortoise since when he reaches the tortoise's starting point *A* it must be at *B*, and when he reaches *B* it must be at *C*, and so indefinitely. The paradox thus postulates that the distances *AB*, *BC*, *CD* . .

being in geometrical progression, the distance *AK*, in which Achilles would overtake the tortoise, is divisible into an infinite geometrical series. See *Plato, Parmenides*; Northrop, *Riddles in Mathematics* (1945).

Zinsser, Hans

American bacteriologist

b. 1878, New York

d. 1940

After being professor at Columbia from 1913-23, Zinsser joined the Harvard Medical School (1923); he was a member of the Serbian commission to investigate typhus (1915), and a League of Nations commissioner to study cholera, 1923. He developed (with his helpers) immunisation methods against typhus (1930).

Zsigmondy, Richard Adolf

Austrian chemist

b. Apr. 1, 1865, Vienna

d. Sept. 29, 1929, Göttingen

Educated at Vienna, Munich and Berlin, Zsigmondy became professor of physics at Göttingen in 1908, and was awarded the 1925 Nobel prize for chemistry. He is remembered for his investigation of colloidal solutions and for his introduction in 1903 of the ultramicroscope which has done so much to advance studies in this field.

INDEX

The numbers refer to columns

- Abdominal aorta, 109
 Aberrations, 49
 Abreaction, 72
 Absolute pitch, 259
 Absolute scale, 187, 242, 252
 Accommodation, 213, 475
 Accumulator, 361, 384
 Acetic acid, 260, 351, 417
 Acetone, 101, 194, 338
 Acetylcholine, 118
 Acetylene, 33, 52, 101, 251, 335, 470
 Achromatic lenses, 1, 135, 196
 Acids, 54, 101, 124, 140, 183, 190, 207, 214, 256, 260, 274, 276, 342, 400
 Acoustics, 19, 98, 152, 213, 216, 266, 288, 339, 363, 377, 399, 460, 463, 472
 Actinide series, 404
 Actinium, 188
 Actinometer, 81, 387
 Actinomycin A, 454
 Adrenalin, 3, 118, 229
 Aeroplane, 19, 270, 450, 465, 473
 Affinity, 10, 60, 124, 342, 427
 Air-pump, 68, 198, 234, 417
 Alcohol, 52, 68, 80, 247, 260, 262, 284, 347, 351, 467
 Aleyonarians, 434
 Aldehydes, 157, 173
 Alexine, 64
 Algebra, 86, 129, 133, 189, 378, 384, 450
 Alizarin, 105, 194
 Alkaline cyanides, 46
 Alkalis, 57, 123, 125, 183, 214, 278, 284, 321, 328, 414, 432
 Alkaloids, 160, 354, 355, 385, 437, 468
 Allotropy, 53
 Alpha-particles, 57, 93, 113, 220, 242, 243, 344, 393, 404
 Alternation of generations, 94, 400, 420
 Aluminum, 131, 191, 205, 217, 302, 339, 470
 Americium, 404
 Amino-acids, 225, 228, 415
 Ammeter, 28
 Ammonia, 38, 52, 64, 101, 125, 201, 262, 321, 342, 366
 Amyl alcohol, 83
 Anaemia, 7, 319, 327, 464
 Anaesthesia, 105, 123, 133, 289, 292, 410, 461
 Analysis, 67, 171, 365, 419, 437, 469
 Anaphylaxis, 382
 Ancestral recapitulation, 325
 Androsterone, 82, 395
 Anemometer, 385
 Ancurism, 109, 232
 Angina pectoris, 341
 Aniline dyes, 52, 97, 160, 225, 258, 355, 392, 403, 445
 Animal heat, 112, 284
 Animism, 417
 Anomalous dispersion, 98, 264
 Anthracene, 15, 140, 274
 Anthrax, 104, 121, 257, 258, 351, 388
 Anti-bodies, 352
 Anticyclone, 180, 408
 Antimony, 108
 Antiseptics, 118, 146, 288, 383
 Antitoxin, 43, 257, 388, 475
 Ants, 167, 230
 Aphasia, 76
 Appendicitis, 7, 161, 348, 440
 Argon, 374, 377
 Aromatic compounds, 235, 355
 Aromatic substitution, 104
 Arsenic, 10, 304, 347
 Arteries, 87, 217, 221, 301, 347
 Artificial silk, 54, 113, 426
 Ascorbic acid, 211, 428
 Asexual generation, 66
 Asparagine, 385, 447
 Aspartic acid, 12
 Asteroids, 3, 182, 340, 358, 400, 471
 Atmosphere, 1, 10, 12, 17, 56, 91, 96, 148, 249, 253, 270, 379, 423, 431, 444
 Atom chain-reaction theory, 331
 Atomic disintegration, 57, 93, 103, 107, 141, 148, 155, 158, 169, 174, 197, 202, 219, 242, 243, 262, 277, 309, 341, 394, 399, 413, 446, 456
 Atomic hydrogen blowpipe, 270
 Atomic theory, 14, 15, 21, 61, 67, 69, 119, 125, 185, 212, 262, 270, 277, 283, 324, 351, 373, 394, 403, 414, 419, 421, 435, 476
 Atomic volume, 261, 314
 Atomic weights, 34, 43, 53, 72, 85, 100, 108, 140, 303, 314, 323, 339, 356, 368, 382, 419, 437, 442
 Atropine, 468
 Aurora, 16, 57, 119, 249, 299, 423
 Auscultation, 265, 439
 Auto-oxidation, 301
 Bacillus brevis, 138
 Bacteria, 52, 104, 121, 138, 194, 214, 222, 250, 257, 258, 279, 302, 351, 357, 442, 454
 Bakelite, 32
 Balance, 214, 385
 Balloon, 32, 56, 57, 95, 183, 190, 314, 322, 359, 379
 Barium, 53, 124
 Barometer, 68, 128, 349, 439
 Baryta, 228, 400
 Bathysphere, 359
 Bauxite, 205
 Beats, 266
 Bees, 26, 230, 377
 Beet sugar, 4, 302
 Behaviourism, 457
 Benzene, 251, 320, 389, 400
 Benzene derivatives, 77, 173, 240, 320

Index—Continued

- Benzoic acid, 85, 240
- Benzyl alcohol, 85
- Beriberi, 146
- Berkelium, 404
- Beryllium, 82, 93, 349, 447, 470
- Beta rays, 185, 309, 393
- Biaxial crystals, 56, 73, 289, 319
- Bile acids, 427, 466
- Bile pigments, 191
- Binomial theorem, 333, 456
- Biology (term), 267
- Bi-prism, 172
- Blood circulation, 153, 209, 237, 294, 357, 406, 415, 449
- Blood, coagulation of, 182, 325
- Blood corpuscles, 279, 288, 301, 426
- Blood, gases of, 39, 294, 357
- Blood groups, 269
- Blood plasma, 211
- Blowpipe, 131, 208, 270
- Bolometer, 270, 448
- Boron, 75, 183, 242, 243
- Brain, 7, 39, 76, 116, 158, 167, 179, 191, 217, 220, 237, 262, 301, 322, 353, 368, 374, 408, 420, 427, 449, 459, 468
- Breathing, 221, 250, 357, 457
- Bridges, 79, 97, 99
- Bromide paper, 426
- Bromine, 35, 293, 300, 315
- Brownian movement, 77, 147, 269
- Bruce, 91
- Bubonic plague, 257, 258, 351, 475
- Bulk modulus, 379

- Cables, 99, 252, 305
- Cacodyl, 81, 83
- Cadmium, 323, 423
- Cæsium, 81, 256
- Caffeine, 160
- Calamine, 302
- Calcium, 53
- Calcium carbide, 470
- Calcium hydroxide, 100
- Calculating machines, 29, 329, 418
- Calculus, differential, 11, 29, 50, 90, 120, 128, 152, 157, 237, 280, 298, 333, 349, 430, 456
- Calculus, integral, 50, 108, 120, 152, 456
- Calculus of variations, 266, 363, 461
- Calendar, 8, 21, 32, 150, 379, 399
- Californium, 404
- Calorimetry, 57, 68, 81, 243, 244, 460
- Camphor, 52, 348, 355, 437
- Canal rays, 192, 419
- Cancer, 40, 158, 243, 457
- Capillaries, 263, 301
- Capillarity, 134, 149, 173, 263, 363, 453
- Carbides, 320
- Carbohydrates, 109, 211, 223, 284, 428
- Carbolic acid, 274, 288, 383, 392
- Carbon, 33, 192, 224, 251, 282, 431, 454
- Carbon assimilation, 66, 235, 285, 406, 468
- Carbon dioxide, 38, 49, 57, 66, 214, 235, 360, 365, 393, 406
- Carbon monoxide, 101, 134, 273, 366, 474
- Carbon tetrachloride, 379
- Cardiac poisons, 469
- Carotid artery, 221, 322
- Carotenoids, 249, 263
- Cascade theory, 54
- Catalysis, 53, 64, 72, 76, 125, 135, 201, 214, 236, 320, 342, 383, 397, 406, 467
- Catarrh, 357
- Catastrophism, 295
- Catheter, 149
- Cathode, 113, 156, 191
- Cathode rays, 57, 72, 113, 192, 223, 281, 362, 386, 422, 435
- Cavity magnetron valve, 375, 399
- Cells, 48, 66, 87, 164, 184, 192, 196, 209, 222, 226, 261, 308, 320, 329, 367, 404, 428, 450
- Cells, electrical, 81, 99, 120, 126, 198, 278, 330, 334, 361, 452
- Celluloid, 348
- Cellulose, 54
- Centrifugal force, 99, 258, 274, 380, 425
- Centrosome, 66, 192
- Cephalopoda, 420
- Cerebellum, 39, 149
- Cerebral angiography, 322
- Cerebrum, 76, 149, 158, 217
- Cerebro-spinal sclerosis, 95
- Ceria, 53, 257
- Challenger expedition, 202, 328, 433
- Chameleon, 447
- Chemical nomenclature, 53, 168, 276
- Chloramine, 376
- Chlorine, 52, 118, 124, 125, 156, 284, 400, 432
- Chlorine monoxide, 35
- Chloroform, 284, 410
- Chlorophyll, 91, 107, 160, 352, 397, 468
- Chloroplast, 148, 398, 401
- Cholera, 258, 308, 351, 357, 388, 478
- Cholesterol, 395
- Chromatin, 164
- Chromatographic analysis, 437, 441
- Chromium, 127, 211, 257, 447
- Chromosomes, 48, 164, 191, 323
- Chromosphere, 204, 239, 290
- Chronometer, 209
- Chyle, 326, 353
- Cinchonine, 91
- Cinematography, 126, 144, 174, 294
- Citric acid, 400
- Classification, botanical, 6, 48, 77, 85, 92, 149, 166, 174, 225, 227, 246, 267, 286, 290, 348, 376, 458
- Classification, chemical, 53, 274
- Classification, mineral, 19, 112, 139
- Classification, zoological, 8, 21, 59, 116, 154, 202, 267
- Clinostat, 398
- Cloud-chamber, 57, 469
- Coal gas, 68, 101, 119, 204
- Cobalt, 71, 211
- Cobalt ammonium compounds, 186
- Cocaine, 468
- Cochine, 58
- Colloidon, 402
- Colloids, 72, 77, 136, 173, 194, 283, 294, 383, 425, 478
- Colour, 4, 97, 267, 294, 333, 405
- Colour blindness (Daltonism), 120, 306
- Colour photography, 4, 236, 288, 294, 472

Index—Continued

- Copyrighting, 108
- Colour vision, 213, 216, 306, 475
- Colymbium, 210
- Combustion, 44, 226, 276, 308, 400, 417
- Combustion, heat of, 16, 134, 272
- Comets, 14, 24, 40, 53, 55, 65, 94, 99, 108, 129, 136, 148, 157, 161, 166, 206, 308, 332, 40, 365, 379, 400, 402, 471
- Compass, law of, 175
- Compass, 252, 330, 354, 416, 450
- Complex numbers, 20, 189, 461
- Complexes, theory of, 245
- Condenser, 284
- Condenser, electrical, 328, 337
- Conductivity, electrical, 186, 195, 207, 262, 282, 299, 340, 435, 454, 458
- Conductivity, heat, 235, 443
- Conic sections, 17, 19, 129, 310, 346, 349
- Conservation of energy, 51, 101, 213, 220, 244, 307
- Constant proportion, law of, 367
- Continental drift, 460
- Continued fractions, 76, 90
- Co-ordinate geometry, 129
- Corals, 121, 319
- Cordite, 3, 132
- Cornea, 213
- Cortisone, 253
- Cosmic rays, 14, 54, 57, 106, 185, 212, 220, 317, 341, 379, 388, 423
- Coumarin, 355
- Coumarone, 161
- Craniology, 59
- Cresosote, 274, 380
- Crescograph, 65
- Cretinism, 453
- Criminology, 180, 292
- Critical temperature, 16, 83, 340
- Cross circulation, 221
- Crustacea, 267, 319, 325, 377
- Cryophorus, 472
- Cryoscopy, 44
- Crystallisation, 115, 210, 261
- Crystals, 25, 56, 68, 69, 123, 139, 173, 190, 274, 301, 319, 339, 364, 386, 423, 434
- Crystals, mixed, 60
- Curari, 265
- Curium, 404
- Current, 14, 24, 244, 253, 282, 339, 452
- Curves, 19, 50, 65, 310
- Cycloids, 349, 439
- Cyclotron, 277
- Cystoscope, 335
- Cytochrome, 250
- Day, length of, 111
- Decimals, 329, 421
- Dementia-præcox, 262
- Density, relative, 18, 68, 208, 417
- Denudation, 21, 122, 188, 198, 376
- Determinants, 237, 416
- Deuterium, 446
- Dew, 10, 190
- Dextrose, 160
- Diabetes, 19, 38, 54, 229, 299, 468
- Dialysis, 194
- Diamagnetism, 45, 269, 362
- Diamond, 81, 173, 320, 431, 460
- Diathermancy, 309, 444
- Diatoms, 8, 326
- Dicotyledons, 376
- Dydium, 324
- Dielectric constant, 2
- Diesel engine, 133, 208
- Diet, 97, 146, 223, 284, 319, 328, 464
- Differential equations, 120, 237, 266, 272, 325, 358, 363, 392
- Differential governor, 409
- Diffraction, 18, 123, 127, 171, 197, 274, 363, 373, 434, 472
- Diffusion, 159, 194, 384
- Digestion, 43, 49, 97, 214, 310, 352, 357, 368, 403, 415
- Digitalis, 470
- Dilution law, 342
- Diphenyl, 161
- Diphtheria, 46, 72, 257, 351, 388, 475
- Dipole moment, 126, 423
- Dislocations, 259, 289
- Dispersion, 197, 332
- Dissection, 84, 177, 217, 449
- Distillation, 183, 285, 380, 392
- Dreams, 172
- Dredge, naturalist's, 326
- Dropsy, 75, 470
- Drosophila, 326
- Duodenum, 217
- Duprene, 335
- Dust, 10, 148, 469
- Dyes, 43, 52, 95, 97, 105, 135, 145, 160, 313, 355, 403, 432
- Dynamite, 335
- Dynamo, 156, 166
- Dynamometer, 60, 252, 409
- Dysentery, 257, 400
- Dysprosium, 61
- Ear, 38, 152, 155, 468
- Earth, age of, 80, 94, 188, 226, 240, 243, 253, 262
- Earth, density of, 9, 33, 65, 68, 91, 304
- Earth, size and shape, 14, 18, 64, 65, 89, 99, 100, 150, 265, 279, 305, 308, 359, 397, 413
- Earth and sun, 21, 70, 109, 148, 179, 222, 368
- Echinoderms, 326
- Echoes, 266, 313
- Eclipses, 33, 127, 239, 290, 432
- Ecliptic, 88, 150, 222
- Eels, 195, 401
- Elasticity, 90, 226, 268, 363, 386
- Electric furnace, 4, 268, 320, 409
- Electric lamp, 101, 144, 164, 270, 331, 426
- Electric motor, 216, 418, 424
- Electricity, 13, 24, 68, 101, 110, 123, 126, 128, 139, 156, 164, 180, 182, 188, 195, 216, 244, 256, 291, 306, 317, 339, 390, 399, 420, 435, 439, 452, 458, 460, 463, 467, 472
- Electricity, atmospheric, 24, 68, 85, 148, 170, 281, 291, 410, 423
- Electricity, static, 48, 189, 195, 198, 432, 458, 472
- Electrocardiograph, 147

Index—Continued

- Electrochemistry, 13, 44, 53, 201, 342
 Electrolysis, 24, 44, 90, 123, 156, 161, 198, 205, 208, 217, 223, 260, 261, 330, 334, 384, 452, 453, 455, 467
 Electromagnetism, 18, 56, 62, 101, 147, 156, 161, 182, 216, 219, 292, 306, 339, 344, 404, 424
 Electrometer, capillary, 288
 Electron, 113, 123, 134, 169, 219, 299, 317, 351, 393, 414, 422, 434, 435, 439, 476
 Electrophorus, 452
 Electroplating, 347
 Electroscopes, 48, 285, 337, 452
 Electro-therapeutics, 24, 139, 357
 Ellipse, 17, 310
 Elliptic functions, 3, 217, 237, 279, 412, 461
 Emanum, 188
 Embryology, 11, 33, 37, 138, 153, 184, 219, 223, 232, 251, 260, 271, 301, 323, 326, 368, 376, 389, 415
 Emotion, theory of, 238, 269
 Entropy, 213, 446
 Environment, 267, 329, 372
 Enzymes, 80, 109, 152, 207, 264, 338, 415, 425, 457, 468
 Epidemics, 223, 427
 Epidermis, 301
 Epilepsy, 205, 369
 Epinephrine, 3
 Equations, 20, 86, 133, 180, 190, 217, 243, 358, 362, 363, 424, 450
 Equilibrium, 421
 Equilibrium, chemical, 59, 96, 188, 199
 Equinoxes, precession of, 11, 14, 99, 109, 188, 222
 Erbium, 324
 Ergosterol, 469
 Ergot, 118
 Ester, 191, 385
 Ether (chem.), 197, 247, 289, 292, 410, 467
 Ether (phys.), 219, 252, 291, 316, 323
 Ethylene glycol, 467
 Europa, 128
 Eustachian tube, 11, 152
 Evolution, 8, 35, 42, 66, 82, 121, 131, 153, 184, 186, 202, 229, 233, 242, 251, 260, 267, 296, 304, 310, 325, 329, 372, 389, 440, 455, 461
 Exclusion principle, 351
 Explosives, 2, 31, 52, 134, 140, 181, 335, 402, 413
 Extrovert, 245
 Eyo, 12, 97, 144, 200, 213, 216, 279, 303, 361, 368, 475
 Fats, 97, 171, 284
 Fault, geological, 447
 Fermentation, 80, 152, 183, 207, 351, 365, 403, 428, 440
 Ferns, 225, 329
 Ferrates, 171
 Fertilisers, 66, 113, 140, 189, 214, 231, 276, 284, 335, 342
 Fever, 64, 242, 427, 474
 Fibrin, 325
 Filters, 81, 94
 Fishes, 8, 33, 34, 152, 184, 326
 Fixed points, 2, 44, 81, 96, 154, 261, 434
 Flame, 181
 Flavins, 249
 Flowers, colouring of, 171, 468
 Fluorescence, 270, 422
 Fluoric acid, 53
 Fluorine, 124, 171, 320
 Fog, 10, 469
 Follicle, 33, 194
 Formaldehyde, 33, 225
 Formic acid, 52
 Formulae, chemical, 77, 170, 251
 Fossils, 116, 130, 292, 345, 412, 420, 450, 468
 Fractures, 269
 Francium, 12
 Free association of ideas, 173
 Free energy, 213
 Free radicals, 107, 192
 Frog, 180, 225
 Fructose, 157, 160
 Fuchsine, 98
 Fumaroles, 4
 Functional differentiation, 389
 Functions, theory of, 51, 53, 102, 168, 183, 237, 243, 358, 363, 384, 392, 430, 461
 Fungi, 42, 104, 170
 Gadolinium, 303
 Galium, 61, 262, 311
 Galvanometer, 24, 68, 147, 213, 251, 309, 336, 362, 364, 404, 424
 Gamma rays, 14, 393
 Gases, discovery of, 77, 91, 110, 204, 214, 308, 365, 374, 440
 Gases, liquefaction of, 16, 52, 83, 100, 110, 119, 132, 156, 244, 249, 250, 286, 299, 340, 360, 474
 Gases, properties of, 16, 27, 34, 68, 95, 96, 100, 110, 114, 118, 119, 123, 126, 134, 183, 190, 194, 216, 226, 244, 269, 293, 303, 309, 317, 379, 444
 Gas mantle, 462
 Gastric juice, 43
 Generator, 126, 156
 Genes, 192, 323, 326
 Geological cycles, 21
 Geological eras, 9, 76, 273, 292, 295, 304, 327, 358, 405, 417
 Geometry, descriptive, 321, 364
 Geometry, non-Euclidean, 63, 92, 96, 183, 289, 383
 Geotropism, 258, 398
 Germanium, 262, 356, 469
 Germicides, 288, 383
 Germ-plasm, 461
 Gestalt psychology, 259
 Gill-slits, 376
 Gin, 465
 Glaciers, 167, 185
 Glutathione, 228
 Glycerine, 52, 400, 413
 Glycogen, 49, 316
 Glycol, 474
 Gnomon, 14, 21, 51
 Gout, 104, 307
 Goniometer, 472

Index—Continued

- Aut, 95, 427
- Graafian follicles, 87, 193
- Grafting, animal, 232, 452
- Gramophone, 47, 144
- Granite, 232, 462
- Graphite, 4
- Gratings, 106, 137, 171, 274, 317, 389
- Gravity, 5, 9, 11, 22, 25, 50, 65, 68, 91, 99, 127, 149, 179, 226, 234, 254, 293, 316, 332, 365, 380, 409
- Great Lastera*, 79
- Groups, theory of, 91, 180, 243
- Guns, 22, 108, 166, 402, 450, 465, 466
- Gyroscope, 167, 252, 414, 416, 465

- Hacmin, 160
- Hæmoglobin, 104
- Hafnium, 109, 221
- Hair-spring, 226, 234
- Halogens, 53, 95
- Hardness, 75, 320
- Heart, 12, 43, 147, 237, 298, 341, 352, 419, 420, 449, 470
- Heaviside layer, 211, 253
- Heavy water, 446
- Helimeter, 65, 135, 171
- Heliotropism, 258, 398
- Helium, 110, 132, 170, 249, 250, 290, 299, 340, 345, 374, 393, 413
- Heredity, 94, 191, 242, 267, 296, 310, 323, 420, 461
- Hermaphroditism, 326, 420
- Herring, 207
- Hexosamines, 283
- Histology, 55, 260, 374, 451
- Hodograph, 206
- Holmium, 102
- Homœopathy, 203
- Homologues, 173, 187
- Hormones, 43, 82, 135, 395, 419
- Hydraulic machines, 22, 70, 322, 330
- Hydrazines, 116, 160, 376
- Hydrochloric acid, 125, 190, 208, 366, 368
- Hydrodynamics, 64, 152, 349, 420
- Hydrogen, 16, 37, 57, 64, 83, 91, 96, 123, 132, 140, 183, 201, 249, 256, 270, 299, 340, 360, 368, 394, 432, 446
- Hydrogenation of oils, 48, 397, 406
- Hydrogen fluoride, 171
- Hydrogen-ion concentration, 100, 415
- Hydrogen peroxide, 402, 432
- Hydrogen sulphide, 49
- Hydrometer, 43, 334
- Hydrophobia, 12, 351, 388
- Hydrostatic balance, 179
- Hydroxylamine, 376
- Hygrometer, 120, 128, 198, 282, 398
- Hyperbola, 17, 310
- Hypnosis, 56, 72, 95, 167, 173, 314
- Hypochlorous acid, 35
- Hysteria, 95, 172, 239, 427

- Ichthyology, see Fishes
- Igneous rocks, 232, 420, 462
- Illium, 228
- Illumination, 267

- Ilmenite, 195
- Immunisation, 46, 64, 308, 478
- Incubation, 11, 301, 377
- Indeterminacy, principle of, 212
- Indigo, 33, 445
- Indium, 380, 382
- Indivisibles, method of, 385
- Induction, 48, 156, 216, 230, 282, 390
- Inferiority complex, 7
- Influenza, 357
- Infra-red rays, 2, 34, 102, 270, 309, 389
- Infusoria, 145, 267, 326
- Inoculation, 241, 258, 265, 280, 351, 473
- Insanity, 171, 229, 262
- Insects, 153, 154, 279, 302, 376, 377, 378, 416, 425, 447
- Insemination, artificial, 415
- Insulators, 90
- Insulin, 38, 54, 299
- Intelligence, 41, 56, 180, 259, 431, 436
- Intercellular spaces, 441
- Interference, 73, 172, 197, 274, 289, 333, 339, 356, 476
- Interferometer, 73, 204, 238, 317, 380, 390
- Internal combustion engine, 117, 133, 208, 282, 317, 342
- Internal secretions, 78, 225, 229, 294, 301, 352, 419, 420, 427, 452, 453
- Intestines, 24, 49, 195, 196, 214
- Introvert, 245
- Invar, 190
- Involution, theory of, 129
- Iodine, 104, 111, 117, 124, 194, 300, 315
- Ionium, 62
- Ions, 60, 76, 103, 148, 155, 156, 285, 388, 439, 455, 469
- Iridium, 431
- Iridotomy, 97
- Irritability, 206
- Isomerism, theory of, 53, 77, 454, 463, 470
- Isomorphism, 320
- Isoprene, 437
- Isostasy, 79, 199, 243
- Isothermals, 231
- Isotopes, 12, 25, 57, 154, 187, 211, 221, 303, 382, 413, 435, 446

- Jet propulsion, 297, 391, 465
- Jupiter, 68, 89, 227, 272, 281
- Jupiter, satellites of, 40, 179, 266, 303, 334, 386

- Kairine, 160
- Ketones, 44, 173, 191
- Kidney, 75
- Kinetic theory, 51, 62, 91, 124, 240, 293, 306, 391, 420, 421, 457
- Krypton, 144, 374, 440

- Lacteal vessels, 24, 215, 353
- Lactic acid, 228, 284, 308, 316, 351, 400, 470
- Laetones, 161
- Lanthanum, 324
- Larynx, 38, 152, 181, 322, 326
- Latent heat, 52, 57, 128

Index—Continued

- Latitude, 222, 368
 Lead tetraethyl, 317
 Least action, principle of, 266, 305
 Least squares, method of, 183, 279
 Lecithin, 468
 Leguminosae, 214, 451
 Lenses, 31, 73, 99, 104, 135, 165, 167, 170, 196, 200, 234, 239, 374, 377, 418, 472
 Leprosy, 207, 442
 Leukaemia, 451, 473
 Lovers, 18
 Lewigite, 335
 Leyden jar, 328, 337
 Libido, 172, 245
 Libration, 88, 179, 266
 Lichens, 42
 Ligatures, 232, 347
 Light, velocity of, 18, 69, 89, 162, 166, 167, 179, 306, 316, 323, 331, 386
 Light, wave theory of, 18, 125, 138, 172, 197, 234, 253, 306, 333, 363, 476
 Lighthouses, 73, 119, 172
 Limestones, 76, 100, 280, 308, 412
 Lithium, 20, 103, 124, 430, 456
 Lithotomy, 97
 Lithotripsy, 55
 Liver, 49, 217, 319, 322, 328, 464
 Lobotomy, 171, 322, 459
 Loci, 102
 Locomotor ataxia, 139
 Logarithms, 74, 200, 217, 329, 447
 Long division, 74
 Longitude, 134, 209, 222, 304, 368, 379
 Loom, 88, 237
 Low temperatures, 132, 164, 187, 242, 248, 250, 340, 360, 440
 Lubricants, 4
 Lunar parallax, 265, 266
 Lung, 301, 406, 428
 Lupus, 159
 Lutea, 238, 445
 Lymphatics, 41, 224, 326, 390, 426

 Machine tools, 78, 466
 Magnesium, 82, 124, 191, 196
 Magnetic materials, 18, 41, 112, 115, 132
 Magnetism, 18, 45, 85, 110, 115, 123, 182, 189, 195, 248, 253, 269, 316, 354, 362, 373, 399, 431
 Magnetism, terrestrial, 5, 56, 75, 149, 183, 188, 231, 252, 281, 330, 390, 397, 423, 460
 Magnetometer, 182
 Malaria, 195, 258, 275, 387, 453
 Mandrake, 133
 Manganese, 177, 201
 Manic-depression, 171, 262
 Mannose, 160
 Manometric flame, 259
 Maps, 14, 79, 89, 100, 139, 164, 199, 206, 231, 312, 368
 Margarine, 97, 397
 Mars, 88, 102, 165, 205, 234, 293, 300, 359, 400, 411, 448
 Mass action, 96, 200, 342, 453, 462
 Mass-spectrograph, 25
 Mastoiditis, 356
 Masurium, 336
 Matches, 455
 Matrices, 91
 Maturation, 48
 Maxima and minima, 157
 Measles, 235, 261
 Meat extract, 284
 Mechanical equivalent of heat, 244, 381
 Medusae, 202
 Membrane equilibria, 136
 Memory, 143, 216
 Mercurial blood-pump, 294, 357
 Mercury (planet), 127, 181, 215, 240, 283
 Mercury (metal), 66, 117, 154, 194, 347
 Mercury vapour lamp, 294
 Meson, 15, 388, 476
 Metabolism, 109, 310, 316, 357, 385, 398, 428
 Metal carbonyls, 58, 301
 Metallurgy, 2, 9, 54, 96, 183, 198, 201, 211, 377, 384, 409, 414, 433
 Meteorites, 5, 55, 94, 129, 345, 400
 Meteorology, 79, 120, 180, 206, 216, 231, 305, 371, 385, 408, 410, 423, 431
 Methane, 52, 400
 Methyl alcohol, 52, 140
 Methylamine, 474
 Methyl ethyl ether, 467
 Metric system, 64, 95, 266, 275
 Micella, 329
 Microchemistry, 365
 Microphone, 230, 464
 Microscope, 1, 13, 153, 165, 192, 226, 236, 279, 288, 380, 386, 439, 478
 Microscopy, 40, 42, 165, 196, 226, 258, 279, 301, 334, 414, 426
 Microtome, 223
 Migrations, 195, 402
 Mimicry, 42, 325
 Mineralogy, 9, 43, 62, 112, 139, 155, 185, 195, 320, 423, 462
 Mineral waters, 49, 365
 Mirrors, 12, 13, 19, 88, 167, 284, 289, 389, 401
 Mitosis, 164
 Molecules, structure of, 5, 77, 101, 111, 126, 251, 352, 374, 409, 425, 446
 Mollusca, 271
 Molybdenum, 211, 224
 Monads, 280
 Monochord, see Vibration of strings
 Monochromatic illumination, 294
 Monocotyledons, 376
 Moon, 5, 14, 21, 68, 88, 163, 179, 281, 300, 330, 402, 438, 448, 450
 Moon, origin of, 121, 240
 Morphine, 300, 406
 Mosquito, 87, 302, 378, 387
 Mosses, 225, 401
 Motor-car, 86, 113, 117, 133, 193, 211, 282, 317, 342, 345, 349
 Motor speech centre, 76
 Mountain-building, 21, 240
 Mucus, 215
 Mule, 112
 Muscles, 61, 139, 152, 180, 192, 206, 209, 221, 228, 237, 316, 368, 404, 426, 428
 Musk, 394
 Mutations, 35, 90, 131, 326
 Mycorrhiza, 170
 Nyxoedema, 78

Index—Continued

Naphthalene, 255, f 4
 Natural selection, 65, 90, 121, 131, 296, 455f
 Nepenthes, 106, 129, 219, 230, 234, 250, 272,
 273, 297, 303, 405, 411, 423, 448, 471
 Nebulae, dark, 40, 240, 411, 471
 Neodymium, 324, 462
 Neon, 100, 374, 435, 440
 Neosalarsan, 146
 Nephros, 75
 Nephrology, 5, 53, 273, 283, 424
 Nerves, 7, 46, 47, 61, 76, 118, 139, 149, 151,
 152, 167, 192, 205, 209, 213, 215, 217,
 220, 260, 270, 291, 300, 326, 352, 374,
 403, 408, 456
 Neurology, 46, 73, 95, 171, 172, 182, 273, 369,
 456, 459
 Neuron, 7, 374, 408
 Neurosis, 73, 173, 239, 245, 459
 Neutron, 93, 141, 158, 197, 202, 242, 373, 476
 Nickel, 112, 321
 Nickel carbonyl, 321
 Nickel-steel alloys, 198
 Nitramide, 76, 376
 Nitric acid, 183, 214, 276, 342, 413
 Nitriles, 437
 Nitrogen, 57, 66, 83, 95, 113, 201, 249, 257,
 340, 360, 366, 393, 406, 474
 Nitrogen fixation, 52, 57, 64, 110, 201, 214,
 268, 451
 Nitrogen pentoxide, 131, 366
 Nitrogen trichloride, 140
 Nitrogen trioxide, 34, 366
 Nitro-glycerine, 413
 Nitrosyls, 301
 Nitrous oxide, 105, 123, 461
 Notochord, 33
 Novae, 70, 128, 405
 Nuclear fission, 57, 93, 103, 141, 158, 174, 197,
 202, 242, 309, 341, 394
 Numbers, theory of, 157, 183, 217, 266, 279,
 319, 412
 Nutation, 69
 Nutrition, 97, 297, 397, 408, 451
 Nylon, 87

Ocean bed, 9, 45, 305, 328, 359, 433
 Oestrone, 135
 Oil shale, 46
 Oil synthesis, 48, 236, 397, 406
 Ophthalmometer, 213
 Opium, 347, 385, 406
 Opsonin, 473
 Optophone, 168
 Orchids, 13, 121
 Organo-magnesium compounds, 197
 Oscillation, 252, 373, 430
 Oscillograph, 139
 Osmium, 431
 Osmosis, 131, 142, 194, 214, 224, 263, 323,
 337, 357, 439
 Ovarian tubes, 156, 194
 Ovum, mammalian, 33, 194
 Oxalic acid, 400
 Oxidation reduction, equilibria, 100

Oximes, 44, 315
 Oxygen, 52, 57, 83, 100, 132, 134, 137, 187,
 221, 226, 276, 294, 299, 308, 339, 358,
 360, 366, 379, 400, 406, 474
 Ozone, 16, 132, 339, 379, 402, 429

 Palladium, 472
 Pancreas, 43, 194, 338, 352, 427
 Paprika, 428
 Parabola, 17, 310
 Parachor, 425
 Paradox, 477
 Paraffin, 380, 389
 Paralysis, 19, 95, 453
 Paralysis agitans, 348
 Paramagnetism, 45, 269
 Paranoid, 322
 Parasites, 104, 275, 336, 378, 387, 473
 Parotid gland, 420
 Parthenogenesis, 279, 291, 420
 Pediments, 188
 Pelvis, 322
 Pendulum, 89, 167, 179, 194, 209, 234, 250,
 304, 380
 Penicillin, 122
 Penicillin, 93, 164, 165
 Pepsin, 403
 Percussion, 26, 439
 Periodic law, 61, 72, 94, 108, 134, 311, 314,
 332
 Peritonitis, 161
 Personality, theory of, 173
 Phagocytes, 308, 473
 Phakoscope, 213
 Phase rule, 159, 188, 387
 Phenanthrene derivatives, 161, 240, 385
 Phenobarbital, 369
 Phenol, 274, 376
 Phenyl cyanide, 157
 Phlebitis, 451
 Phlogiston, 44, 49, 256, 276, 366, 417
 Phosphorescence, 45, 85, 132, 139, 145, 281,
 377, 445
 Phosphoric acid, 177
 Phosphorus, 71, 73, 400, 428, 433, 470
 Phosphorus oxychloride, 474
 Photochemistry, 13, 45, 59, 437, 285, 331, 387
 Photoelectricity, 146, 148, 185
 Photography, 4, 32, 40, 68, 117, 124, 137, 144,
 145, 168, 219, 236, 268, 288, 294, 400,
 426, 429, 452, 472
 Photography, stellar, 40, 63, 106, 127, 189,
 218, 230, 401, 471
 Photometer, 65, 81, 148, 185, 215, 243, 294,
 359, 390, 452
 Photon, 283, 388
 Photoperiodicity, 58
 Phrenology, 180
 Phthalic acid, 274
 Pl, 19, 76, 92, 151, 196, 267, 368, 407, 450
 Piezo-electricity, 110, 288
 Pilocarpine, 270
 Pituitary gland, 116, 225
 Planetary orbits, 5, 9, 11, 24, 59, 70, 109, 179,
 180, 222, 254, 266, 272, 283, 332, 363,
 366, 370

Index—Continued

Planets, surface temperatures, 68, 102, 334, 356; 422
 Plankton, 102, 207, 216
 Plants, breeding of, 55, 82, 242, 296
 Plants, distribution, 231, 400
 Plants, feeling in, 65
 Plants, sex of, 13, 84, 196, 225, 367, 416
 Plastic surgery, 133, 429
 Plastics, 56, 86, 255, 348
 Platinum, 472, 77, 84, 93, 131, 135, 257, 290, 472
 Pleochroic haloes, 215, 243, 394
 Plumbates, 171
 Pluto, 166, 293, 438
 Plutonium, 107, 404
 Pneumatic trough, 77, 204
 Pneumonia, 95, 336
 Polarisation, 9, 45, 56, 73, 107, 156, 167, 172, 234, 255, 268, 274, 301, 334, 386, 399, 416
 Polar molecules, 126
 Poliomylitis, 269
 Pollination, 13, 325, 367, 416
 Polonium, 114
 Polygraph, 298
 Polymethylenes, 394
 Polypeptides, 160
 Polyploidy, 58
 Porphyrins, 160
 Positive system of philosophy, 107, 298, 392
 Positron, 15, 57, 134
 Potash, 123, 140, 302, 432
 Potassium, 82, 123, 354
 Potassium arsenate, 299
 Potassium ferrieyanide, 191
 Potassium peroxide, 183, 432
 Potential, 195, 252, 363, 384
 Pragmatism, 238
 Praseodymium, 324, 462
 Prehistoric life, 116, 304, 344
 Printing, 71, 271, 313, 418
 Probability, theory of, 50, 157, 272, 349, 372
 Producer gas, 321
 Progestin, 82
 Progressive muscular atrophy, 139
 Promethium, 72
 Prominences, solar, 127, 239, 200, 356
 Prontosil, 135
 Protactinium, 197, 202, 309
 Protein, 25, 136, 261, 283, 284, 310, 325, 382, 415, 425, 437
 Proton, 57, 103, 421, 456, 476
 Protoplasm, 264, 320, 329, 440
 Prussic acid, 52, 183, 400
 Pterodactyl, 116, 304
 Puerperal fever, 226, 468
 Pulleys, 18, 19
 Pulse, 165, 178, 217, 398
 Pure-line theory, 242
 Purines, 160
 Purpurin, 105
 Pus, 215
 Pyrheliometer, 16, 364
 Pyridines, 15, 127
 Pyro-electricity, 173, 210
 Pyrometer, 60, 96, 328, 384

Quadrant electrometer, 28
 Quantics, 91
 Quantum theory, 54, 61, 96, 125, 134, 146, 169, 206, 212, 292, 294, 317, 331, 341, 351, 352, 360, 373, 414, 421, 476
 Quaternions, 102, 206, 429
 Quinazolines, 60
 Quinine, 91, 203, 354
 Racemic acid, 351
 Radar, 17, 375, 399, 459
 Radiant heat, 63, 167, 294, 309, 336, 365, 420, 467
 Radiation pressure, 24, 113, 161, 277, 306, 340, 365
 Radicals (chem.), 107, 192, 247, 260, 274, 284, 466, 470
 Radioactivity, 45, 62, 114, 115, 148, 155, 158, 185, 187, 202, 220, 222, 240, 242, 243, 262, 277, 285, 309, 344, 363, 393, 413, 462
 Radiolaria, 202
 Radiometer, 113, 277, 380
 Radio-micrometer, 68
 Radium, 62, 113, 114, 115, 128, 132, 220, 243, 285, 393
 Radium emanation, 114, 137, 413
 Railways, 79, 119, 421, 441, 463
 Rainbow, 31
 Reaction velocity, 24, 59, 136, 198, 224, 364, 462
 Reflection, 12, 31, 157, 172, 217, 253, 301
 Reflex actions, 205, 353, 408
 Refraction, 12, 31, 68, 69, 73, 118, 127, 138, 190, 206, 253, 289, 309, 333, 413
 Refraction, double, 41, 139, 234, 301, 422
 Refractive index, 73, 98, 118, 132, 138, 140, 190, 264, 413
 Relativity, 29, 144, 146, 269, 281, 293, 317, 318, 319, 323, 341, 360, 411
 Renal calculi, 214
 Resistance, 98, 164, 244, 264, 339, 464
 Resonator, 213
 Rhennium, 75, 336
 Rhesus monkey, 269
 Rhodium, 127, 472
 Rinderpest, 258
 Rocks, age from radioactivity, 43, 62, 155, 215, 222, 226, 243, 262, 345, 394, 417, 462
 Rocks, classification of, 19, 76, 273, 292, 295, 327, 358, 405, 412, 420, 463
 Rocks, formation of, 232, 240, 420, 462
 Rosaniline, 160
 Rothamsted Research Station, 189, 276
 Rubber, 193, 265, 335, 437, 475
 Rubidium, 81, 256
 Ruthenium, 258
 Saccharimeter, 274
 Saccharin, 154
 Safety-lamp, 124, 421
 Safety-valve, 346
 Salicylic acid, 260
 Saliva, 352, 427
 Salvarsan, 146

Index—Continued

- Samarium, 61
- Sandstones, 100, 280, 308
- Sap pressure, 303
- Saturn, 63, 88, 89, 179, 218, 234, 250, 272, 273, 281, 306, 359, 424
- Scandium, 311, 335
- Scarlet fever, 235
- Schizophrenia, 322
- Screw, 20, 150, 161, 411
- Scrofula, 18, 37, 466
- Scruvy, 59, 285
- Searchlight, 416
- Sea-urchin, 138, 219
- Secretin, 43, 419
- Sedimentation, equilibrium of, 355
- Sediments, 100, 188, 280, 308, 470
- Seismology, 316
- Selenium, 53, 75
- Self-assertion, 7
- Senility, 78, 308, 452
- Series, mathematical, 19, 76, 151, 168, 183, 196, 312, 363, 478
- Serum therapeutics, 16, 64, 269, 336, 357, 382, 388, 415, 437, 475
- Sewing machine, 229
- Sex-impulse, 7, 172, 245
- Sextant, 201
- Sexual process, 48, 155, 167, 219
- Shales, 100, 280, 308
- Shingles, 298
- Silicon, 53, 201, 255
- Silicon compounds, 4, 41, 96, 112, 320, 339
- Silkworms, 42, 301, 351
- Silver nitrate, 124, 400
- Sinus aorta, 221
- Siphon, 345
- Siren, 83
- Sirius, 53, 99, 230
- Sleeping sickness, 78, 275
- Slide-rule, 200, 343
- Smallpox, 159, 241
- Smoke abatement, 104
- Snake venom, 229, 336
- Soap, 97, 111, 171, 208
- Soap-films, 377, 380, 390
- Soda, 123, 146, 208, 278, 302, 328, 414
- Sodium, 90, 123, 138
- Sodium arsenate, 299
- Sodium chlorate, 369
- Sodium hypochlorite, 118, 304
- Sodium peroxide, 183, 432
- Sodium sulphate, 190
- Solar parallax, 148, 229, 265
- Solar system, origin of, 94, 137, 213, 240, 253, 272, 325
- Solstices, 14
- Solution, 2, 24, 29, 44, 126, 173, 221, 312, 357, 376, 423, 462
- Solutions, solid, 60
- Sound transmission, 68, 256, 444, 472
- Sound, velocity of, 18, 264, 313, 424
- Specific heat, 81, 101, 261, 272, 330, 356, 379, 437, 460
- Specific heat of gases, 96, 140, 356, 386
- Specific heat of water, 84, 389
- Specific inductive capacity, 156
- Specific nerve energies, 326
- Specimens, preservation of, 68, 194
- Spectacles, 50, 200
- Spectra, stellar, 6, 29, 136, 137, 140, 170, 250, 359, 393, 405, 411, 422, 451
- Spectroheliograph, 204
- Spectroscopy, 13, 16, 29, 61, 81, 113, 128, 137, 170, 172, 239, 249, 256, 262, 290, 299, 309, 317, 362, 367, 374, 380, 382, 387, 389, 392, 407, 419, 422, 429, 431, 446, 448, 472, 477
- Spectrum, line series, 37, 352, 396, 414
- Spectrum, solar, 2, 4, 13, 16, 137, 140, 149, 170, 239, 256, 270, 288, 290, 333, 389, 472
- Spermatozoa, 66, 219, 279, 367, 415
- Spherical aberration, 104, 167, 234, 377, 401, 418, 472
- Spinal cord, 78, 205, 300, 301, 357, 374
- Spinels, 4
- Spinning frame, 22
- Spinning jenny, 208
- Spintharoscope, 113
- Spireme, 164
- Spleen, 217, 224, 301, 341
- Sponges, 202
- Spontaneous generation, 21, 351, 378, 415, 444
- Springs, water, 49, 345
- Square roots, 90, 390
- Squinting, 133
- Stammering, 133
- Standard lamp, 448
- Standard time, 1
- Stannates, 171
- Stannic chloride, 284
- Starch granules, 279, 329
- Star-fish, 377
- Stars, binary, 99, 140, 240, 423, 424, 451
- Star catalogues, 20, 53, 59, 75, 150, 164, 189, 193, 206, 218, 222, 265, 358, 368
- Star clusters, 218, 438
- Stars, constitution of, 144, 240, 393, 405, 422
- Stars, dark, 53, 192
- Stars, distance of, 6, 53, 109, 189, 215, 423
- Star magnitudes, 20, 63, 359
- Stars, motion of, 20, 62, 136, 142, 144, 162, 163, 206, 229, 230, 240, 249, 300, 405
- Stars, sizes of, 204
- Stars, variable, 2, 140, 193, 402, 407
- Statistics, 180, 372
- Steam-engine, 70, 84, 86, 108, 113, 150, 217, 332, 421, 441, 459
- Steam-hammer, 330
- Steamship, 47, 79, 150, 160, 176, 349, 391, 411
- Stearin, 97
- Steel, 2, 54, 201, 211, 409, 433
- Stereochemistry, 207, 283, 351, 418
- Stereoscope, 73, 461
- Sterols, 395, 418, 469
- Stethoscope, 26, 265
- Stomata, 301
- Stratosphere, 96, 129, 211, 249, 359, 379, 431
- Streptomycin, 454
- Strontium, 53, 112, 124, 228, 256, 257, 430
- Strychnine, 91, 300, 354, 355
- Sugars, 4, 38, 49, 157, 160, 211, 236, 274, 302, 351, 367, 440, 468
- Sulphanilamide, 135
- Sulphur, 77, 127, 193, 208, 347, 455

Index—Continued

- Sulphur dioxide, 366
 Sulphuric acid, 54, 101, 214, 276, 328
 Sun and planet motion, 459
 Sun, rotation of, 6, 87, 140, 179
 Sun, size of, 14, 21
 Sun-spots, 87, 137, 157, 179, 261, 303, 397, 403
 Superconductivity, 299, 340
 Superheating, 346
 Superphosphates, 276
 Superpolyamides, 87
 Supersonic flight, 297
 Suprarenal glands, 3, 7
 Surface chemistry, 5, 270, 282, 383
 Surface tension, 149, 272, 361, 425
 Surveying, 8, 100, 200, 217, 375, 413
 Suturing of blood-vessels, 87
 Sweating, 118, 237, 368
 Symbiosis, 42, 170
 Symbols (maths.), 98, 189, 342, 373, 378, 390, 456
 Synthesis, 33, 39, 46, 52, 60, 64, 87, 101, 116, 154, 160, 161, 171, 173, 194, 197, 201, 208, 211, 212, 236, 260, 263, 342, 355, 394, 400, 438, 467, 471, 474
 Syphilis, 146, 169, 336, 388, 399, 427

 Tables, mathematical, 10, 69, 74, 254, 266, 329, 379, 381, 447
 Tangents, 385
 Tantalum, 53, 147
 Tartaric acid, 351, 355, 400
 Tautomerism, 192
 Teeth, mammalian, 343
 Telogony, 152
 Telegraph, 182, 230, 324, 409, 464
 Telepathy, 41, 113, 381
 Telephone, 47, 144, 212
 Telescope, reflecting, 13, 88, 167, 196, 201, 218, 226, 273, 333, 374, 401, 439
 Telescope, refracting, 65, 99, 165, 170, 179, 234, 239, 303, 374, 472
 Television, 34, 126
 Telewriting, 168
 Tellurium, 34, 72, 256, 257, 325
 Temperature chart, 474
 Terbium, 324
 Termites, 195
 Terpenes, 127, 355, 394, 437, 456
 Testosterone, 395
 Tetanus, 12, 46, 257, 388
 Thalamus, 171, 322, 459
 Thallium, 113, 268
 Theelin, see Oestrone
 Thermionics, 382
 Thermite process, 191
 Thermo-chemistry, 52, 272, 382
 Thermocouple, 68, 102, 309, 334, 335, 354, 356, 384, 405
 Thermodynamics, 73, 86, 101, 187, 199, 213, 224, 252, 268, 285, 293, 307, 330, 360, 382, 421
 Thermometers, 44, 66, 68, 92, 154, 222, 252, 377, 379, 393
 Thermometers, air, 84, 179, 282, 379
 Thermometers, clinical, 12, 398, 439, 474
 Thermometers, resistance, 84, 409

 Hiazoles, 60
 Thin sections, 334, 414
 Thiophen, 315
 Thoracic duct, 24, 41, 353
 Thorium, 53, 344, 374, 382
 Thulium, 102
 Thyroid, 39, 78, 208, 229, 253, 259, 455
 Tides, 31, 51, 65, 121, 229, 254, 317
 Tissue, 55, 87, 209, 279
 Titanium, 195, 257, 356
 Tobacco mosaic virus, 418
 Toluene, 131, 154, 161, 354, 438, 456
 Torpedo, 465
 Torsion balance, 68, 91, 110, 149, 316
 Tourmaline, 167
 Tourniquet, 356
 Trachea, 149
 Tracheotomy, 72
 Transformations, 284, 293
 Transformer, 148, 186, 418
 Transmission gear, 345
 Transport numbers, 223
 Transversals, 129
 Trephining, 76, 356
 Triangle of forces, 421
 Trigonometrical functions, 10, 128, 151, 159, 168, 189, 200, 222, 267, 342, 450
 Triphenylmethyl, 192
 Tropine, 468
 Tropism, 258, 291, 398
 Troposphere, 431
 Truss, 50
 Trypanosomes, 145, 258, 400
 Tryptophan, 228
 Tsetse fly, 78
 Tuberculosis, 95, 258, 336, 351, 388, 415, 428, 454
 Tumours, 158, 191, 292, 451
 Tuning fork, 259
 Tungsten (wolfram), 148, 211, 270
 Turbine, 274, 349
 Typhoid, 72, 177, 242, 280, 378, 383, 473
 Typhus, 169, 242, 285, 334, 478
 Tyrothreine, 138

 Ultracentrifuge, 425
 Ultra-microscope, 478
 Ultra-violet rays, 40, 102, 159, 317, 356, 384, 416, 469
 Unconscious, the, 7
 Unit of length, 16, 29, 317
 Universe, theory of, 24, 62, 142, 144, 147, 240, 249, 281, 300, 318, 381, 393, 407, 411
 Uranium, 113, 114, 211, 240, 257, 353, 374, 382
 Uranium salts, 45, 114, 353
 Uranium-235, 141, 197, 202
 Uranium-X, 113, 155
 Uranus, 5, 53, 59, 126, 217, 281, 283, 411
 Uranus, satellites of, 218, 273, 424
 Urea, 125, 471
 Uric acid, 33, 160, 400

 Vaccination, 241, 258, 280, 336, 351, 473
 Vacuum flask, 132
 Vacuum tube, 113, 270

Index—Continued

Vagga, 41, 156
 Valency, 2, 170, 192, 251, 262, 274, 283, 352, 409, 425, 463
 Valve, thermionic, 126, 164, 224, 375, 399
 Vanadium, 127, 387, 406
 Vanillin, 437
 Vapour pressure, 29, 119, 252, 376
 Variation, 42, 82, 267, 296, 329
 Vector analysis, 188, 211
 Vegetable cells, 226, 320
 Vegetative hybridisation, 296
 Veins, 153, 217, 221, 301, 449
 Venom, 229, 336
 Venus, 9, 88, 127, 148, 165, 179, 229, 240
 Vernalisation, 296
 Veronal, 160
 Vibration microscope, 288
 Vibration of strings, 51, 98, 266, 313, 370
 Virtual velocities, 266
 Viscera, 43
 Viscose, 54
 Viscosity, 24, 56, 73, 422, 437
 Visible speech, 47
 Vitamins, 120, 135, 144, 146, 176, 211, 212, 223, 228, 249, 263, 310, 408, 428, 438, 469
 Vivisection, 150, 158, 300
 Volcanoes, 4, 79, 185, 231, 463
 Voltmeter, 28
 Vortex rings, 429, 435
 Water, composition of, 91, 140, 183, 198, 299, 321, 323, 366, 384, 446, 452, 459
 Water, density of, 85, 128, 228
 Water, purification of, 100, 112, 204, 285

Water-gas, 276
 Wave mechanics, 234, 402
 Welding, 191, 270
 Wheat, 55
 Whooping cough, 64
 Will-to-power, 7, 172, 245
 Winds, 206, 305, 385, 408
 Wireless telegraphy, 17, 72, 126, 139, 168, 211, 219, 253, 291, 302, 306, 363, 364, 414
 Wireless valve, 126, 164, 224, 375, 399
 Wolframite, 147
 Wounds, 44, 79, 87, 118, 347
 X rays, 25, 40, 107, 125, 126, 269, 274, 317, 324, 326, 355, 386, 422
 X ray spectrometer, 25, 69, 107, 262, 364, 409
 Xenon, 144, 374, 440
 Xylomite, 348
 Year, length of, 21, 150, 222
 Yeast, 80, 250, 351
 Yellow fever, 87, 336, 351, 378
 Ytterbium, 303
 Yttrium, 177
 Zebras, 152
 Zeeman effect, 212, 293, 477
 Zeolite, 112
 Zinc, 273, 302, 323, 347
 Zirconium, 53, 257
 Zodiacal light, 88, 402

